Determinants of consumers' acceptance of insects as food and feed: A cross-cultural study.

Ane Telles Sposito Gonçalves Neves
Masters Degree in Consumption Science and Nutrition
Department of Geosciences, Environment and Territory Planning 2015

Advisor
Doctor Luís Miguel Cunha, Associate Professor, Faculty of Sciences, University of Porto

Todas as correções determinadas pelo júri, e só essas, foram efetuadas.

O Presidente do Júri,

Porto, ______/______/_________

MSc

To my husband and my parents.

Acknowledgements

I would like to use this opportunity to express my sincere gratitude to everyone who has supported me through these two years of study. This would have been much more difficult without your help and, for that, I am very thankful.

Firstly and foremost, I am greatly thankful to my advisor Prof. Luis Miguel Cunha for his aspiring guidance, knowledgeable advices, invaluably constructive criticism, and sustained motivation throughout this project. I am extremely grateful for all the knowledge he has transmitted to me. I would like to thank him for making possible for me to participate in such an inspiring project. I would also like to express my gratitude for his kindness and patience with me at all times.

Likewise, I would like to thank all my other Professors: Prof. Marial Daniel Vaz de Almeida, Prof. Pedro Moreira, Dr. Pedro Graça, Dr. Ada Rocha, Dr. Sara Rodrigues, Dr. Jorge Queiroz, Dr. Susana Fonseca, Prof. Olivia Pinho, Dr. Mário Cunha for all the knowledge transmitted during these two memorable years.

I also thank my friend Diana Pereira for her companionship during these 2 years. She has most definitely made this time less lonely and more pleasant. Together we have shared all the good and difficult times, endless hours of study and numerous group assignments together. Thank you for being such a reliable friend at all times.

Additionally, I would like to express my sincere gratitude to Maria Helena Barbosa and Bárbara Barbosa Neves for helping me overcome some of the difficult times during these years. Thank you for listening to my numerous outpourings and for all the advices and kind words.

Also, I would like to thank my parents for all the support, not only throughout this year but also throughout my whole life. None of this would have been possible without you, and for that I am eternally thankful. Thank you also for always believing in me and most essentially thank you for your unconditional love.

Most importantly, I would like to express my endless gratitude to my husband. Who was everyday during this year with me, carefully listening to my worries, concerns and breakdowns. Among all the special things you mean to me, you also show me everyday how great of a friend you are. Thank you for all your support; you are my foundation throughout all my challenges.

Abstract

The production of sufficient poultry, fish and livestock represents a serious challenge for the future, based on a fast growing world population and increasingly demanding consumers. This rapidly rising industry is generating a variety of environmental problems such as land degradation, deforestation and water pollution. A scenario in which can negatively affect food security in a global scale. In this sense, insects for food and feed are a practical solution in terms of sustainability due to numerous reasons including high feed conversion ratios, low emission of greenhouse gas and ammonia. Likewise, insects are highly nutritious, being a good source of high value proteins, fiber, good fats, calcium, vitamins, and energy. Yet, consumers' acceptance of insects as food and feed has not been established.

The main objective of this study is to evaluate the determinants of consumers' of insects as food and feed. To assess this information, a questionnaire was developed and was applied through a web-based survey in Norway (n=363) and Portugal (n=303) to attain different perspectives within Western societies. Cluster analysis was applied based on the degree of acceptance of the different forms of insects as food (direct and indirect) to identify different consumer segments. These segments were labeled as: *Disgusted* (C1), *Rejecters* (C2), *Feed acceptors* (C3) and *Acceptors* (C4). For the prediction of perceived acceptance of insects as food and as feed, application of binary logistic regression was executed for each of the countries. Results show that, for Portugal and Norway, disgust was confirmed to decrease the likelihood of acceptance of insects as food and feed. Contrarily, participants that accept sushi are more likely to accept insects as food and feed. Moreover, this study has also profiled consumers with high levels of acceptance of edible insect as food and feed. This profile is younger males, who are interested in the environmental impact of their food choices, showing low levels of neophobia and disgust, and high familiarity with edible insects.

These results can create input for insect based product development, market positioning of edible insects and insect based products, and communication of strategies in Western societies.

Keywords: edible insects; entomophagy; sustainable food choices; alternative food sources; acceptance of novel foods.

Resumo

O crescimento rápido da população mundial associado ao facto de os consumidores se mostrarem cada vez mais exigentes nas suas escolhas, representam um desafio sério para os setores da avicultura, piscicultura e pecuária. Na tentativa de fazer face a estes desafios, estes sectores económicos têm vindo a causar graves problemas ambientais, como são disso exemplo a degradação dos solos, o desmatamento e a poluição da água. Esta situação terá certamente impacto negativo em termos de segurança alimentar numa escala global. Neste sentido, a inclusão de insetos na alimentação humana e animal surge como uma solução prática em termos de sustentabilidade por várias razões incluindo emissões reduzidas de gases com efeito de estufa. Os insetos são também altamente nutritivos sendo uma boa fonte de proteínas, fibras, gorduras boas, cálcio, vitaminas e energia. No entanto, a aceitação por parte dos consumidores da utilização de insetos na alimentação humana e animal não foi ainda estabelecida.

O principal objetivo deste estudo foi a avaliação dos determinantes da aceitação de insectos como alimento humano e animal. Para recolha de informação, foi desenvolvido e aplicado um questionário online na Noruega (n=363) e em Portugal (n=303), de forma a obter diferentes perspetivas em diferentes sociedades ocidentais. Foi aplicada uma análise de clusters com base no grau de aceitação de diferentes formas de insetos como alimento humano (direto e indireto), de forma a identificar diferentes segmentos de consumidores. Os segmentos foram estabelecidos como: "Enojados" (C1), "Os que rejeitam" (C2), "Os que aceitam como alimento animal" (C3) e "Os que aceitam como alimento humano e animal" (C4). Para a previsão da aceitação de insetos como alimento humano e animal foi aplicada uma regressão logística binária para cada país. Os resultados mostram que para Portugal e Noruega, o nojo reduz a probabilidade de aceitação de insetos como alimento humano e animal. Contrariamente, os participantes que aceitaram o sushi têm uma maior probabilidade de aceitação de insetos como alimento humano e animal. Adicionalmente, este estudo traçou o perfil dos consumidores com maior nível de aceitação de insetos como alimentação humana e animal. Este perfil define-se como, jovens do sexo masculino, com alto interesse nos impactos ambientais das suas escolhas alimentares, demonstrando baixos níveis de neofobia alimentar e nojo e elevada familiaridade com insectos comestíveis.

Estes resultados podem contribuir para o desenvolvimento de novos produtos à base de insetos, definição de posicionamento de insetos e produtos à base de insetos no mercado e para novas estratégias de comunicação nas sociedades ocidentais

Palavras-chave: insetos comestíveis, entomofagia, escolhas alimentares sustentáveis, fontes alimentares alternativas, aceitação de novos alimentos.

Table of Contents

List of Abbreviations

PRI – Population Reference Intake

EdS – Encosternum delegorguei Spinola

FAO – Food and Agricuture Organization of the United Nations

WHO – World Health Organization

UN – United Nations

EU – European Union

USA- United States of America

UK – United Kingdom

NEIMAN – Medicinal and Edible Insects of Manipur

INSFEED – Insect Feed for Poultry and Fish

BLSS – Bio Regenerative Life Support System

SANCO – South African National Civic Organization

TSE – Transmissible Spongiform Encephalopathy

PAP – Processed Animal Protein

FNS – Food Neophoby Scale

FCQ – Food Choice Questionnaire

SDT – Self-Determination Theory

IFT – Institute of Food Technologists

KMO – Kaiser Meyer Olkin

SPSS – Statistical Package for Social Sciences

List of Tables

List of Figures

1 Introduction

Trends towards 2050 anticipate a stable increase of the worlds' population to 10 billion people (von Koerber and Leitzmann 2011, Ray, Mueller et al. 2013, Donatiello 2015), imposing an increase on food/feed production from existing agro-ecosystems, resulting in an even greater pressure on the environment (Van Itterbeeck and van Huis 2012). The impacts stem from factors such as greenhouse gas emissions from animals and manure (Van Rooyen 2014), cultivation and fertilization of feed crops and pasture (Leibensperger, Mickley et al. 2012), deforestation and grassland conversion (Kjellstrom, Lemke et al. 2013), and emissions caused by the production of inputs (such as fertilizers), transporting and processing (Popp, Lotze-Campen et al. 2011).

Due to the continued growth of both per capita per income and worlds population, the demand for livestock products is projected to grow by 70% by 2050 (de Boer, Schosler et al. 2014). On the one hand, in developing countries, the serious problem of food security is worsen everyday by this increase in the worlds´ population (van Huis 2013). On the other hand, in industrialized countries, where the problem of food security is a minor worry, problems associated with food refer to 2 main factors: environmental sustainability of food production and food safety (Premalatha, Abbasi et al. 2011). For these purposes, new ways must be found to increase production while preserving natural habitats, food quality and biodiversity since scarcities of agricultural land, water, forest, fishery, biodiversity resources, nutrients and non-renewable energy are foreseen (Klunder, Wolkers-Rooijackers et al. 2012).

These trends towards 2050 are also likely to reinforce other problems, especially for public health, since livestock products, in particular red meat and processed meat, have been appointed as risk factors for cardio vascular disease, some types of cancer, type 2 diabetes and other non-communicable diseases, among western culture (Klink 2014, Guo, Wei et al. 2015, Van Hoof, Hemeryck et al. 2015).

In the United States, a very high average consumption of red meat (48kg without bones) per capita per year is estimated (Machovina and Feeley 2014, Bastide, Chenni et al. 2015). The most representative data in Europe have been collected in the Netherlands, where red meat consumption is soothing at around 39.2 kg (meat with bones) per capita per year (Hawkes 2014). Additionally, data shows that actual daily meat protein intakes among adults in Europe stands at, or more frequently above, the Population Reference Intake (PRI) of 0.83g/kg body weight (Belluco, Losasso et al. 2013). Expectations are that in the next decades, 40% of traditional meat consumption will be substituted by other protein sources (Verkerk, Tramper et al. 2007, McCusker, Buff et al. 2014). In this sense, the use of alternative protein sources such as insects is a viable solution (Klunder, Wolkers-Rooijackers et al. 2012).

It has been suggested that the consumption of edible insects can be promoted for three reasons: health, environment, and livelihood (economic and social factors) (Nadeau, Nadeau et al. 2015). For instance, insect harvesting and rearing can offer livelihood opportunities for poorer sections of society since insect harvesting/rearing is a low-tech and low-capital investment option (van Huis 2013, Lensvelt and Steenbekkers 2014).

As we know, some insects are considered pests to the agriculture. In the tropics, there are numerous examples of "pests" being used as food and feed (van Huis 2013). The utmost irony is that all over the world billions of money are spent every year to save crops that contain no more than 14% of plant protein by killing another food source (insects) that may contain up to 75% of high quality animal protein (Premalatha, Abbasi et al. 2011).

Still, although being a practical solution, the consumption of edible insects has declined in many societies (Rumpold, Katz et al. 2014). Deeply embedded in the Western psyche is a view of insects as dirty, disgusting, or even dangerous (Belluco, Losasso et al. 2013, Megido, Sablon et al. 2014). It has been suggested that insect cuisine is, for Westerners, emblematic of the unknown, a threat to our psychological and cultural identity (Ryan 2014). In contrary, in some developing countries, where consuming insects is still a common practice, the changes in life-style and habits are causing the slow disappearance of this traditional custom (Looy, Dunkel et al. 2014).

As the fast-paced world is facing numerous problems, it is sometimes easy to lose sight of valuable traditional knowledge and practices (Harris and Mohammed 2003). We have the propensity to think of traditional customs and habits as obsolete or primitive

(Shackleton, Shackleton et al. 2002). Nevertheless, experience throughout numerous fields has emphasized the value and benefits to be gained from combining customary

knowledge and methods with modern understanding and science, such is the case of edible insects (Motte-Florac and Ramos-Elorduy 2002).

As we know, humans are very unique in the sense they can have access to a variety of food sources. Nevertheless, mainly in developed countries, humans have chosen a limited number of animals and plants from which they can acquire their energy and nutrients (Belluco, Losasso et al. 2013).

One of the key features of globalization in recent decades has been the creation of what is leaning on a near universal cultural system based essentially on Western values, customs and habits (Illgner and Nel 2000). Inevitably, globalization is leading to the spread of the Western dietary habits to developing countries, with a consequent loss of food diversity and traditional habits (Belluco, Losasso et al. 2013).

For instance, in many north-east Indian tribes, the increased “westernization” of traditional wisdom is leading the use of insects as food and medicine to be at risk to be lost (Chakravorty, Ghosh et al. 2013). In this sense, the Western attitude is very important because acculturation towards western lifestyles tends to cause a reduction of edible insects’ use and acceptance, frequently in populations that are economically marginal, without affording the means by which the lost nutrition can be replaced (DeFoliart 1999).

The main objective of this study is to evaluate the determinants of consumers’ acceptance of insects as food and feed. Some specific objectives are: (1) To characterize different consumers’ segments regarding their acceptability of insects as food and feed; (2) To evaluate the relationship between the insects’ acceptance as food and feed and neophobia, disgust level, and other psychographic or personality traits; (3) To draw a cross-cultural study comparison on the acceptance of insects as food and feed within western cultures.

2 Literature Review

2.1 Entomophagy

Insects are described as a class of invertebrates within the arthropod phylum that have a chitinous exoskeleton, three pairs of jointed legs, a three-part body (head, thorax, and abdomen), compound eyes, one pair of antennae and, generally, one or two pairs of wings (Stork, Grimbacher et al. 2008).

The scientific term for insect consumption is “entomophagy” however the term “insectivory” is also used (O'Malley and Power 2014). Animals that eat insects are identified as insectivores (Webster, McGrew et al. 2014). Moreover, certain species of carnivorous plants can also obtain nutrients from insects (McGrew 2014).

Although many animals eat insects, the term entomophagy is usually applied when referring to human consumption of insects (Harris and Mohammed 2003). This term is favored when the consumed arthropods symbolize only one constituent of a diet, which typically includes many other food groups as well (Rothman, Raubenheimer et al. 2014). Therefore, an omnivorous organism, feeding on vegetables, eggs, fruits, meat and fish may also be entomophagous, i.e. an eater of insects (Navon, Keren et al. 1998).

Some fungi (Domnas and Warner 1991) , nematodes (Mauleon, Barre et al. 1993) and insects (Thompson 1999) can attain their nutrition from other insects. In this case they are also termed entomophagous, this includes specially the case of biological control application (Wille 1951). More specifically, they could be also categorized into predators, parasites and parasitoids, while viruses, bacteria and fungi that are grown on or inside insects can also be characterized "entomopathogenic" (Naranjo-Lazaro, Mellin-Rosas et al. 2014).

Occasionally, entomophagy is described largely involving the consumption of arthropods that are not insects, myriapods (centipedes mainly) and as arachnids (tarantulas mainly) (Modesto, Scott et al. 2009). Entomophagy does not refer to the consumption of other arthropods, specially crustaceans such as lobster, shrimp and crab (Rumpold, Katz et al. 2014).

Although a few earlier publications have dealt with human entomophagy (von Ihering 1930, Dalduf 1938), it was in 1951 that Fritz Simon Bodenheimer, with a book entitled as Insects as human food positioned the study of entomophagy on a scientific path (Bodenheimer 1951). Bodenheimer pointed out that nearly every group of insects is eaten among numerous cultures of the world and that the use of insects for human consumption certainly goes back to the beginning of humanity. It was the first time a global analysis on insects as food was presented and discussed in a historic context (Van Itterbeeck and van Huis 2012).

Before humans began to farm, insects may have signified an essential part of their diet and a significant role in human nutrition (Dufour 1990). It is evident from fossilized feces analysis that humans have historically eaten insects (Katayama, Ishikawa et al. 2008). For instance, evidence of coprolites from caves in the Ozark Mountains was proven to contain, mites, ticks, ants, lice and beetle larvae (Dodd, Lacki et al. 2011). It has also been suggested that evolutionary precursors of *Homo sapiens* were also entomophagous (Aigbodion, Egbon et al. 2012).

Amongst primates such as tamarins and marmosets, insectivory is also identified to numerous levels, and it has been suggested that the earliest primates were nocturnal, arboreal insectivores (Skinner 1994). Likewise, most existing apes are now a days insectivorous to a certain extent (Bass 1991).

In north of Spain, cave paintings in Altamira probably from between 30,000 and 9,000 BC, illustrate the gathering of wild bee nests and edible insects, implying an apparent entomophagous culture (Schabereiter-Gurtner, Saiz-Jimenez et al. 2002). In China, cocoons of wild silkworm (*Theophilia religiosae*) from around 2,000 to 2,500 years BC were discovered in the ruins of Shanxi. They were found with big holes, implying that its population consumed the pupae (Kato 1987).

A lot of the research on prehistoric diets concentrated on the idea of finding meat, i.e. hunting of large animals (Bryant 1974, Becker, Alfonso-Durruty et al. 2014, Hoover and Williams 2015). This has been thought to be a vital socio-cultural feature in ancient times (Betsingerl and Smith 2007). Contrarily, in regards to animal protein, archaeological evidence points to an extensive diet that included birds, fish, rodents, lizards, turtles, rabbits, mollusks, crabs, shellfish and insects (Sutton 1995). An analysis of hunter-gatherer diets suggested that invertebrates such as insects accounted for up to 20% of consumed calories in various traditional cultures (Kaplan, Hill et al. 2000).

Ancient entomophagy practice has changed very little over time in terms of the way insects are consumed (Reinhard, Johnson et al. 2012). Many regions of the world stopped practicing it for various reasons such as the development of agriculture, changes in habits, leading entomophagy to a practice usually associated with fear, disgust, and obsolete (Megido, Sablon et al. 2014). Today, entomophagy is a practice common mainly some parts of Africa, Asia and South America, in areas where food security is very low and people cannot afford to choose their source of nutrients (Nadeau, Nadeau et al. 2015).

Sill, little research has focused on the reasons why entomophagy has declined in many areas of the world. Additionally, more research is needed in terms of what factors can contribute to its practice in other parts of the world, especially in Western societies. Since insects are commonly eaten for a long time in many parts of the world, entomophagy is a possibility to question our own cultural conditioning, and expand our opinions of what the word “food” can be (Gahukar 2012).

2.1.1 Edible Species

Research on edible insects shows that some of the most commonly consumed insects and arachnids include dragonfly, lice, cicadas, crickets, grasshoppers, ants, various beetle grubs (e.g. mealworms) (Johnson 2010), the larvae of the darkling beetle or rhinoceros beetle (Rothman, Raubenheimer et al. 2014), various species of caterpillar (e.g. mopani worms, bamboo worms, waxworms and silkworms) (Mbata, Chidumayo et al. 2002), tarantulas and scorpions (Gorham 1979). Only a few insect species are poisonous and inedible, such as blister beetle, birdwings, milkweed butterfly, battus butterfly (Ramos-Elorduy 2005)

It is predicted that over 2000 insect species are consumed by 3071 different ethnic groups in the world, adding up to around 2 billion consumers (Megido, Sablon et al.

2014). Furthermore, possibly, there are hundreds or maybe thousands more that have not been sampled or discovered yet (Kelemu 2015). Table 1 ordinates the most commonly eaten insects based on taxonomic orders, common English names and number of species.

Table 1 – Number of edible insect species reported in the world. Source: Ramos-Elorduy (2005)

Order	Common English name	Number of species
Thysanura	Silverfish	1
Anoplura	Lice	3
Ephemeroptera	Mayflies	19
Odonata	Dragonflies	29
Orthoptera	Grasshoppers, cockroaches, crickets	267
Isoptera	Termites	61
Hemiptera	True bugs	102
Homoptera	Cicadas, leafhoppers, mealybugs	78
Neuroptera	Dobson flies	5
Lepidoptera	Butterflies, moths (silkworms)	253
Trichoptera	Caddis flies	10
Diptera	Flies, mosquitoes	34
Coleoptera	Beetles	468
Hymenoptera	Ants, bees, wasps	351

2.1.2 Regions of the world

Edible insects are generally consumed in developing countries in subtropical and tropical regions. A study conducted in Mexico identified Africa, Asia, Central and South America as the areas with the highest records of places where insect species are eaten (Table 2) (Ramos-Elorduy 2006).

Table 2 - Number of edible insects recorded per continent and number of consuming countries. Source: Ramos-Elorduy (2006)

Continent	Number of species recorded	Percent of total	Number of consuming countries
Asia	349	20	29
Australia	152	9	14
Africa	524	30	36
Americas	679	39	23
Europe	41	2	11

The importance of entomophagy within the context of food security and indigenous' technical knowledge has been recently explored in Africa. The results indicate the contribution in which insects make to the diet of rural Africans. It was also concluded that insects have a considerable potential for alleviating nutritional inadequacies in poor rural communities and can be used, in some instances, as a vehicle for economic empowerment (Illgner and Nel 2000).

Research indicates that termites (winged sexuals) and caterpillars are the most extensively eaten and marketed insects in Africa, and countless other insects are also important from the food perspective, economically, ecologically, and/or nutritionally. (DeFoliart 1999).

In South Africa, data on entomophagy has been collected from different areas. Data for one village in KwaZulu-Natal Province and two in Limpopo Province revealed that 68% of 150 households consumed edible insects (Shackleton, Shackleton et al. 2002). In Mametjam 93% of 110 households consumed 19 insect species including flying ants, termites and grasshoppers (Twine, Moshe et al. 2003). Research has also stated that in Bushbuckridge entomophagy was predominant in 72% of 300 households (Dzerefos and Witkowski 2014).

It has been suggested that in southern Africa one of the generally desired edible insects is the Encosternum delegorguei Spinola (EdS), a species of stinkbug. In southeastern Zimbabwe, this species is eaten by the Karanga population as a delicacy (Gardiner and Gardiner 2003) as well as by two ethnic groups in South Africa, the Vhavenda and the Mapulana (Shackleton, Shackleton et al. 2002) which are geographically apart from each other. In Vhavenda, stinkbugs have been recognized as a high-value food product that generates considerable revenues (Dzerefos, Witkowski et al. 2009).

During the winter dry season in southern Africa, stinkbugs are collected from trees in plantations and woodlands when the insects group together into football-sized clusters (Shackleton, Dzerefos et al. 1998). This is very handy for collectors since at this period of the year wild edible plants and homegrown produce are limited (Harris and

Mohammed 2003). The growing availability of stinkbugs for sale has raised a worry of whether or not harvesting could actually be sustainable in South Africa (Shackleton, Dzerefos et al. 1998)

Around 250 edible species have been reported in rural regions of the sub-Saharan Africa, and can be easily accessed in case plant crops fail to prosper and certain zones become drought-stricken (Harris and Mohammed 2003).

Research conducted in 3 different ethnic groups of Papua and New Guinea determined that insects were eaten in both places as source of food. It has also concluded that (a) entomophagy has advanced in Papua and New Guinea autonomously from African and Australian influences; (b) the number of species consumed is related to the population density; and (c) the threats of malnutrition could be lightened by a wider use of insects food (Meyerroc.Vb 1973).

It has been documented that Cameroonians that live near forested areas typically collect wild plants and insects (Pimentel, McNair et al. 1997). Research suggests that many wild/traditional foods are physically available in Cameroonian cities most of the time, including fruits, vegetables, spices, and insects (Sneyd 2013).

The population in Congo appears to consent the idea of consuming of insects. In Congo, more than 65 species of insects in at least 222 families have been stated as food. Moreover, it is estimated that insects provide 10% of the animal protein produced annually in Congo, in comparison with 47% for fishing, 30% for game, 10% for grazing animals, 2% for poultry and only 1% for fish culture (Illgner and Nel 2000).

Research conducted in Zimbabwe determined that insects are the most inexpensive source of animal protein for the humble rural communities. Furthermore, it states that insect consumption avoided many probable cases of kwashiorkor (a form of severe protein-energy malnutrition), and that their use as food should be stimulated (DeFoliart 1999).

In Zambia it has been established that caterpillars are accessible everywhere during the wet season (Meyer-Rochow 1973). Caterpillars are the single most significant source of nutrients during “hunger months,” which are from November to February (Obopile and Seeletso 2013). Equally, on the Lala tribe caterpillars are a large part of the diet for three or four months of the year (40% of the relishes from November to January) (Nachay 2013). Moreover, they can be sold for a good price to traders from the Copper Belt or exchanged for salt, grain, beads, tobacco, clothes or soap (Meyerrochow 1975).

Research states that Nigerians have had a direct or an indirect experience with entomophagy, although it is more prevalent in rural than in urbanized areas (Banjo, Lawal et al. 2006). As elsewhere in Africa, the more educated people are, the more reluctant to admit that indigenous customs, including the eating of insects, still exist (Illgner and Nel 2000).

In different parts of Asia, the high consumption of grasshoppers/locusts has matched with decreased pesticide use in India, Nepal and the Philippines (Raksakantong, Meeso et al. 2010). In Manipur, northeastern India, people from various ethnic origins collect and eat numerous insect species situated in rivers, lakes, ponds and puddles. It is a usual habit in the area (Shantibala, Lokeshwari et al. 2014).

In India (Chakravorty, Ghosh et al. 2011) and Mexico (Melo, Chavez et al. 2004), Pentatomidae and EdS stinkbugs are gathered and consumed cooked or raw. Research on the stinkbugs Atizies taxcoensis A, Euchistus sufultus S and EdS reveal good nutritional value which is crucial for some undernourished citizens of the area (Melo, Chavez et al. 2004).

In Manipur, because of its high availability and flavor, aquatic insects, among edible insects, are one of the most favorite within consumers. There is an abundance of aquatic insects in various inland water bodies during the rainy season. In the valley region of the state, there are various inland freshwater lakes that perform as a source of aquatic edible insects (Shantibala, Lokeshwari et al. 2014)

Thailand is probably the leading country in consuming and producing insects as animal feed (YhoungAree, Puwastien et al. 1997). Some insects such as bamboo caterpillars, crickets, wasps, and locusts are sold as delicacies in the best food shops and restaurants (Yang, Siriamornpun et al. 2006). These edible insects are wild harvested, semi-cultivated or farmed (Halloran, Vantomme et al. 2015). The Thai government has played a part in encouraging insect consumption, particularly during locust plagues, and, as a consequence, fried locusts and locust fritters appear extensively in city markets

(Meyerrochow 1975). In urban areas, insects are well accepted and bought as food by people from various economic levels (DeFoliart 1999).

The most commonly eaten insects in Japan have been the rice-field grasshoppers (mainly *Oxya yezoensis*), also eaten fried and slightly seasoned with soy sauce, version popularly known as Inago (Payne and Nonaka 2014). After a large reduction, populations of these grasshoppers have finally enlarged recently as the consequence of the reduced pesticide use (Yoshida, Suzuki et al. 2013). Inago, an insect based food, is now re-emerging in supermarkets, dinner tables and restaurants, even though it is still sold as a luxury item (Mitsuhashi, Mizuno et al. 2013). Insect based foods such as inago, zazamushi, and hachinoko, are found on menus in restaurants all around Tokyo (Raksakantong, Meeso et al. 2010).

Similarly, in South Korea it has been documented that the reduced use of pesticides was followed by an increase in sales of the rice-field grasshopper (*Oxya velox*, known as Metdugi) (Moon, Kim et al. 2009). Pupae canned silkworms (*Bombyx mori*) are also popular, as they are elsewhere in East Asia, and are found in most markets in Seoul. They are also exported for many other international countries (Kang, Kim et al. 2012).

In Central and South America, entomophagy is a very common practice (Dar 2014, de Boer, Schosler et al. 2014). For instance, in Mexico, it has been proposed that the “industrialization” of insects (the establishment of small industries in the countryside for the mass-culture of insects as food) works for the benefit of rural economies and for the nutritional stability in the country as a whole (Ramos-Elorduy 2008). Research has also concluded that in Brazil, insects play an important role for the diet of the indigenous populations (costa-Neto 2010). In Colombia, the Colombian leafcutter ants (*Atta* spp.) are a considered a national delicacy, corresponding in price and gastronomic importance to the Russian caviar or the French truffles. This type of ant is consumed across country in many different regions (Ramos-Elorduy 2006).

Clearly, there has been a lot of research focusing on mapping the consumption of insects in distinct parts of the world. Still, very little research has focused its attention on the reasons why entomophagy has declined in some specific areas of developing countries. Suggestions imply that the answer to that is in the westernization of many cultures in developing countries (Lensvelt and Steenbekkers 2014, Megido, Sablon et al. 2014, Nadeau, Nadeau et al. 2015) Still, more research is needed on why this practice has decreased throughout the years and what are the factors contributing to this decrease in order to understand why entomophagy remain a traditional custom is some habitual areas and is becoming obsolete in others (DeFoliart 1999).

2.1.3 Benefits

2.1.3.1 Nutritional and medicinal value

Research has pointed that edible insects, as a nutrient-rich food source, can contribute to a balanced diet and have the potential to promote human health (Gorham 1979, Raubenheimer, Rothman et al. 2014), while improving food and income security, (Belluco, Losasso et al. 2013, Yates-Doerr 2015) especially among economically disadvantaged populations (Christensen, Orech et al. 2006, Chakravorty, Ghosh et al. 2011, Gahukar 2012).

Being highly nutritious (Belluco, Losasso et al. 2013, Neuerburg 2014, Ryan 2014, Nadeau, Nadeau et al. 2015), insects are rich in protein, particularly in the dried form (40–75 g/100g dry weight), commonly stored or sold in village markets of developing countries (Defoliart 1995). Insects can offer to a diet a high quality protein, which has a high concentration of essential amino acids (46–96% of the nutritional profile) and a high digestibility (77–98%) (Verkerk, Tramper et al. 2007).

They have been pointed as a viable source of good fats and provide lipids of easily digestible fatty acid composition (Bednarova, Borkovcova et al. 2014). Insects are also a great source of fiber, accounting for about 10% of the whole dried insect (Rumpold, Katz et al. 2014), due to its high chitin content (a fibrous substance comprising of polysaccharides, which is the main component in the exoskeleton of arthropods) (Merzendorfer 2011).

Research has shown that insects also have reasonable amounts of carbohydrates (Komprda, Zornikova et al. 2013) and provide a valuable and balanced admixture of minerals such as Calcium and trace elements such as Iron and Zinc to a diet (Christensen, Orech et al. 2006, Verkerk, Tramper et al. 2007). They are also known for containing various vitamins such as B12 (Melo-Ruiz, Sanchez-Herrera et al. 2013) and a high energy contributing to a high caloric diet particularly needed in famine-stricken areas of the world (Rumpold and Schluter 2013, Shantibala, Lokeshwari et al. 2014).

It is frequently suggested that insects can meet a function equivalent to the more conventional vertebrate-derived meats (Premalatha, Abbasi et al. 2011, Nadeau, Nadeau et al. 2015) and compositional analyses of insects appear to support this (Johnson 2010, Melo-Ruiz, Sanchez-Herrera et al. 2013, Rumpold and Schluter 2013). Many insect species comprise as much (or more) protein than fish or meat (Melo-Ruiz, Sanchez-Herrera et al. 2013, Verbeke 2015). Table 3 provides the nutritional value of some edible insects traditionally eaten in Mexico compared to meat. When compared to meat, grasshoppers have a superior protein, mineral and carbohydrate content (Ramos-Elorduy 2005).

Table 3 - Nutritional value of edible insects species (g/100g dry weight). Source: Ramos-Elorduy (2005)

	Protein	Fat	Mineral	Carbohydrates		Kcal
				Structural	Others	
Orthoptera						
Grasshoppers, locusts	61–77	4–17	2–17	9–12	4–21	362–427
Coleoptera						
Beetles	21–54	18–52	1–7	6–23	1–19	410–574
Lepidoptera						
Butterflies, moths	15–60	7–77	3–8	2–29	1–29	293–762
Hymenoptera						
Bees, ants	1–81	4–62	0–6	1–6	8–93	416–655
Meat[a]	45–55	40–57	1.4–2.3	0–1.5	0	433–652

The nutritional potential of short-horned grasshoppers, insects commonly used as food for tribes in Arunachal Pradesh in India, has been recently analyzed. Comparisons between their meat and conventional meat type have shown that the mineral content on them was generally higher than conventional meat types. (Chakravorty, Ghosh et al. 2014). Their protein content is constituted of 18 amino acids, including all of the essential ones, except for methionine. It has been suggested that these insects could be recommended as a replacement of vertebrate animal food items when needed (Rumpold and Schluter 2013, Nadeau, Nadeau et al. 2015)

More research have also related comparisons between conventional vertebrate-derived meats and insects in fatty acid and amino acid profiles, vitamin and mineral composition, as well as energy and protein levels (Raubenheimer and Rothman 2013, Wehi, Raubenheimer et al. 2013, Raubenheimer, Rothman et al. 2014, Rothman, Raubenheimer et al. 2014).

The nutritive content of potentially edible aquatic insects has been evaluated lately to notify consumers in India concerning its nutritional qualities and recommended intake quantities. A high gross energy and a good amount of protein content were reported among these insects. High levels of calcium, magnesium and sodium were found present in these insects, proposing that they are a suitable source of minerals. Anti-nutritional properties were under 0.52%, indicating a non-toxic level. In terms of antioxidant activity, aquatic insects, such as *C. tripunctatus*, presents a strong antioxidant activity of 110 µg/mL. It has been suggested that these insects may have a positive impact in environment management health and food security (Shantibala, Lokeshwari et al. 2014).

Besides their highly nutritional value, insects have also been suggested to be “healthy foods” (Nachay 2013, Chakravorty, Ghosh et al. 2014). Insects collected from forest spaces are normally free from chemicals and clean, and are considered to be an “organic food”. Some species are also believed to also have valuable medicinal properties (Srivastava, Babu et al. 2009).

The term Entomotherapy is defined as the application of insects for medicinal purposes (Chakravorty, Ghosh et al. 2011). Insects and the substances extracted from them have been used as medicinal means by many cultures (Meyer-Rochow and Chakravorty 2013). Medicinal and Edible Insects of Manipur (MEIMAN) is a unique database on medicinal and edible insects recently developed, which comprises 51 insect species. It has been developed through a collection only in that region, over a period of 2 years (Shantibala, Lokeshwari et al. 2012). This database has the purpose not only to help people who seek for an alternative type of aid, but also to hope that other insects from other parts of the world will be added in the future.

2.1.3.2 Insect farming

Research points out that in many places insects are plentiful and widely available (Popp, Lotze-Campen et al. 2011, Ryan 2014), and can be easily cultivated (van der Spiegel, Noordam et al. 2013, van Huis 2013), demanding minimal space, needing far less breeding space than larger animals (Vogel 2010) and producing far less pollution (Dar 2014). Furthermore, the whole insect can be used or processed into food, contrarily to larger domestic food animals, whose offal, bones and blood are almost never used as food (Melo-Ruiz, Sanchez-Herrera et al. 2013).

Since meat production contributes to between 14 to 22% of all greenhouse gases sent into the atmosphere every year (Scholtz, Schonfeldt et al. 2014), it has been suggested that insects can offer specific benefits over conventional livestock for those who want to reduce their environmental footprint such as diminished greenhouse gas and ammonia emission (Looy, Dunkel et al. 2014, Ryan 2014).

Additionally, research shows that insects are known for their capacity to survive under a diversity of ecological circumstances (Garrouste 2009). They have short life cycles and can be grown very quickly from an egg to a standard selling size in around 45 days (Gahukar 2012).

It has also been shown that, unlike mammals, insects have a high reproductive ability (Henry, Gasco et al. 2015). Some species, such as house crickets, can lay around 1,200 to 1,500 eggs in a period between 3 to 4 weeks (Illgner and Nel 2000).

Research indicates that insects feed on a far broader variety of plants than conventional livestock (Rumpold and Schluter 2013). It has been suggested that they can also efficiently incorporate waste and side streams into the production systems since numerous insects, such as beetles, grasshoppers, crickets and flies are able to eat agricultural waste or plants that humans and traditional livestock are not able to (Klunder, Wolkers-Rooijackers et al. 2012). By converting biomass that humans are not able to consume into edible insect mass, it has been suggested that insects do not compete with the human food supply, as do vertebrate livestock such as chickens and cows, which are mainly fed with corn and grain (Li, Kwon et al. 2014).

Research on 'minilivestock' operations indicates that feed conversion ratios for edible insects are significantly more efficient than for swine (Hardouin 1997), poultry (Paoletti and Bukkens 1997) and beef (Branckaert 1995, Defoliart 1995, Pellett 1997). For instance, cows typically eat 8 g of feed to gain 1g in weight, while insects may demand less than 2 g of feed for the equivalent weight gain (Pellett 1997).

This is partly because of the fact that insects are "cold-blooded" or poikilothermic (use less energy to sustain body temperature) (May 2005). Furthermore, that insects are exothermic (they acquire their heat from the surrounding environment), whereas birds and mammals are endothermic having to heat themselves up, requiring lots of energy and, therefore, a bigger impact on the environment and natural resources (Dar 2014).

Research suggests that, comparatively speaking; the fact that insects can live on a fifth of the amount of food needed of familiar livestock is a key benefit when taking in consideration the impact of our footprint on the environment (Halloran, Vantomme et al. 2015).

This efficiency lowers the quantity of animal feed required to produce the same amount of "meat," by lessening the need for area of land for producing food for livestock; and the usage of pesticides (that can be high-priced, damaging to the environment and pose a hazard to human health) and the quantity of water used for irrigation;(Premalatha, Abbasi et al. 2011).

Research shows that insects consume much less water than vertebrate livestock by gaining hydration straight from food (Boardman, Sorensen et al. 2013). Crickets, for instance, only demand a tiny quantity of food and water to mature. For example, it is necessary to have around 1 gallon of water to grow 1 pound of crickets and 200 gallons of water to grow simply one cow (Ivy, Johnson et al. 1999).

Because insects are so dissimilar to humans, they have less risk of producing pathogens threatening to human health when compared to livestock production (van Huis 2013, Looy, Dunkel et al. 2014) Furthermore; in general, they also cost little to source when compared to other animals (Illgner and Nel 2000, Dzerefos and Witkowski 2014)

In this sense, aside from their nutritional and environmental benefits, experts also see an extensive prospect for edible insects to offer income and jobs for rural people who capture, rear, process, transport, and market insects as food (Belluco, Losasso et al. 2013, Henry, Gasco et al. 2015, Kelemu 2015).

2.1.3.3 Insects as feed

Although the European Union (EU) is self-sufficient in animal protein for human consumption, its dependency on the import of plant-based protein for use in animal feed is estimated around 70 percent (Makkar, Tran et al. 2014). Feed costs account for 50–70 percent of the total cost in animal production, and therefore, price changes of animal feed ingredients have a major impact on livestock farming profitability (FEFAC 2012). These economic issues (dependencies) highlight the strategic importance of building alternative protein strategies using novel protein sources in animal feed sector (van Huis 2013).

There is an emerging interest in exploring the use of insect as feed. The environmental benefits of producing and using insects as animal feed are undeniable (Premalatha, Abbasi et al. 2011), and considerable advantages have been accredited to the consumption of insects in animal diets (Verbeke, Spranghers et al. 2015). While the total environmental effect of insect rearing is still debated (Makkar, Tran et al. 2014), e.g. depending on rearing systems in consideration, the value of substrates used and of the final products (Ryan 2014), there is a agreement that insects may be raised on organic waste or low valuable by-products from agriculture and the food industry (Klunder, Wolkers-Rooijackers et al. 2012), generating valuable protein with a nutritive value equivalent to the commonly used alternative soybean meal (Henry, Gasco et al. 2015).

As previously mentioned, insects are a good source of fatty acids, amino acids and micronutrients (Rumpold and Schluter 2013). The leftover from insect rearing may be applied as an organic fertilizer, with a result of a closed circle principle (Oonincx, van Itterbeeck et al. 2010). When comparing to livestock for human consumption, insects can more efficiently convert feed into biomass; they can be reared on smaller spaces with a consequent higher yield per hectare than usual (e.g. soybeans), and produce an emission of greenhouse gasses and ammonia per kg meat that is much lower than for cattle or pigs (Oonincx, van Itterbeeck et al. 2010).

Insect meals in industrial quantities are now being produced by some companies such as AgriProtein and EnviroFlight (Rumpold and Schluter 2013). Some insect species are currently being used in developing countries, as feed for certain fish species, pigs, poultry and pets, such as the housefly (Musca domestica), the black soldier fly (Hermetia illucens), crickets and grasshoppers (e.g., the house cricket Acheta domesticus), and mealworms (e.g., Tenebrio molitor) (van der Spiegel, Noordam et al. 2013).

There have been a few projects launched and sponsored in order to aid this growing sector. For instance, Insect Feed for Poultry and Fish (INSFEED), is an recently funded International Development Research Centre project, which offers support to improve income-generation, food and nutritional security in Uganda and Kenya by creating insect-based feeds for safe, cost-effective and sustainable fish and poultry production (Kelemu 2015).

On-going research on insect as animal feed is concentrating on issues such as diet formulation, type of feed substrate to grow the insects, nutritional values of the insects produced, performance of animals that are fed with the insects and protein quality (van der Spiegel, Noordam et al. 2013).

For instance, protein quality of insects as feed for cats and dogs has been recently compared to other feed sources such as poultry fishmeal, soybean meal and meat meal. Insects such as housefly pupae, black soldier fly, house crickets and cockroaches were recognized to be very high in protein and an adequate option as feed for dogs and cats (Bosch, Zhang et al. 2014).

Additionally to the quality of the protein, it has been recognized that other topics such as feasibility of mass-production, efficiency of conversion of organic side streams, product safety, and pet owner perception are essential for future dog and cat food application of insects as alternative protein source (Bosch, Zhang et al. 2014).

2.1.3.4 Aquaculture sector

The aquaculture sector, in particular, is viewed as a segment with a significant prospective for using insects as feed (Makkar, Tran et al. 2014, Mlcek, Rop et al. 2014, Henry, Gasco et al. 2015, Verbeke, Spranghers et al. 2015), and this sector has been raising discussions around the most appropriate insect species in feed formulas (van Huis 2013).

The reduction in the availability and the consequent rise in the prices of fish oil and fishmeal have urged the pursuit for sustainable alternatives for aquaculture feeds (Henry, Gasco et al. 2015). Insects, which are naturally a part of the diet of fishes, are a viable solution since they have a limited need for arable land and leave a small ecological footprint (Makkar, Tran et al. 2014).

In terms of expenses for production, aquaculture feeds is 40–70% of the total expense of the fish produced (Bendiksen, Johnsen et al. 2011, Buentello, Jirsa et al. 2015) and is particularly high in the aquaculture of carnivorous fish that demand large quantities of fishmeal (Manzano-Agugliaro, Sanchez-Muros et al. 2012). To substitute fish oil and fishmeal, soy and other terrestrial plants rich in lipids and proteins have been used as an alternative in the diet of aquaculture fish (Gatlin, Barrows et al. 2007, Tacon and Metian 2008, Bowzer and Trushenski 2015). Yet, the decline in palatability of the meal (Rodriguez-Miranda, Ramirez-Wong et al. 2014), the occurrence of anti-nutritional factors in plant meals (Berntssen, Julshamn et al. 2010, Berntssen, Ornsrud et al. 2015) and the possible complications of the inflammation of the digestive tract (Tacon and Metian 2008, Soares, Coutinho et al. 2011) are of significant worry.

Furthermore, since the fast growing human population has put pressure on the use of arable land (Doos 2002), and the ecological footprint of these protein-rich plants, in terms of the quantity of energy and water necessary for their production, this may alter the sustainability of such alternatives to fishmeal and fish oil (Henry, Gasco et al. 2015).

As insects are constituents of the natural diet of both marine and freshwater fish (Ganga, Tibbetts et al. 2015, McMahon, Thorrold et al. 2015) and since they are rich in lipids, amino acids, minerals and vitamins (van Huis 2013) and leave a small ecological footprint (low need for water and energy, no need for arable land) (Oonincx and de Boer 2012), they have been appointed as prospective alternatives to Fish oil and Fishmeal (Kaliba, Engle et al. 2010, Shepherd and Jackson 2013).

Moreover, insect larvae can quickly transform low quality organic waste into good quality fertilizer, decreasing the final mass of manure by 50%, of phosphorus waste by 61–70% and of nitrogen waste by 30–50% (van Huis 2013). Insects also decrease the load of pathogenic bacteria in the micro flora of manure (Liu, Tomberlin et al. 2008). Additionally, the end product of this very effective bioconversion of manure is an enormous quantity of insect larvae or pre-pupae rich in lipids (30%) and proteins (40%) (Park, Kim et al. 2015).

Various insects such as Odonata, Hymenoptera, Diptera, Trichoptera, Coleoptera, Lepidoptera and Hemiptera also demonstrate antibacterial peptides and/or antifungal activity (Boulanger, Bulet et al. 2006), and that can extend the shelf life of insect-containing feeds (Zhao, Lu et al. 2010).

Clearly insects as animal feed are a viable solution. There is a hope that the appreciation and dependence on insects as valued food and feed sources will improve environmental awareness and help to adopt positive conservation attitudes (Belluco, Losasso et al. 2013).

2.1.3.5 Agro space

Nearly 70–75% of all animal species existing on earth are insects and, together, they play a significant role in recycling materials in the terrestrial biosphere (Katayama, Ishikawa et al. 2008). Insects have been considered a key element to space agriculture (Tong, Yu et al. 2011).

In a space-based agro-ecosystem insects can process waste, recycle materials, pollinate plants, and serve as food and feed. They can perform a number of functions without conflicting with plant production. The design of agro-eco systems could also offer insight into improving the management of Earth's biosphere and long-term sustainability. Space agriculture can be enhanced by integrating insects as constituents and is a favorable approach to meet human nutritional needs in space. (Katayama, Ishikawa et al. 2008).

Research has recently investigated the prospect of using insect food for feeding astronauts in space. When space exploration period surpasses two years, bio regenerative life support system (BLSS) is viewed as a viable possibility to assure a sustainable habitat for astronauts. During the experiment, the insects were fed with stem lettuce leaves and mulberry during the first three instars and the last two instars, in that order. The conclusion was that feeding silkworms with plants biomass inedible to humans is a hopeful method to the production of high-quality animal protein and processing of waste in the BLSS, as well as for people living in extreme and/ or agro-ecologically impoverished environments (Tong, Yu et al. 2011).

2.1.4 Food Safety, Legislation and Policy

It is acknowledged that western legislation is very conservative about new ingredients or foods (Belluco, Losasso et al. 2013). The rising interest in the use of insects for food and feed has directed to a strong concern from researchers, companies and organizations to evaluate the legal context that regulates production, processing, sales and consumption of insects (van der Spiegel, Noordam et al. 2013).

In the vast majority of countries in the world, standards for the trade and protection of insects and insect products in food and feed do not exist (Belluco, Losasso et al. 2013). The development of regulation is urgently needed to provide the industry with clear rules. In order to permit consumers to make knowledgeable decisions, certification schemes can play a role together with labeling to safeguard consumers’ safety (van Huis 2013).

Although entomophagy is a usual custom in many areas of the world, there are only a few cases of national regulations that govern insects for human consumption. In countries where insects collaborate to local diets, nature conservation is frequently a matter of great importance. Where entomophagy is not usual, the existing regulatory discourse concentrates mainly on consumer protection and food safety (Halloran, Vantomme et al. 2015).

In Europe, the sale of edible insects is currently subject to regulation. The Commission now requires parts or extracts of insects sold as food, such as crickets' wings, to be certified for safety and approved as novel foods. Still, the sale of whole edible insects, such as an entire cricket (wings intact) is governed by national regulations (Yates-Doerr 2015).

Belgium became the first EU country to officially approve the sale of 10 species of insect at the end of 2013, and one of the main supermarkets in Netherlands began stocking insect products towards the end of 2014 as the Netherlands liberalized its laws. Other countries, such as Luxembourg, have been unwilling to loosen laws on edible insects and require all insect products to undergo extensive testing and attain EU authorization before being sold (Halloran, Vantomme et al. 2015).

Only lately insects have been added to the sustainable food discourse. Nevertheless they have been mostly ignored from regulatory frameworks and have not yet been included to policy documents. Additionally, even in countries where there is a common practice of eating a diversity of insect species, they do not display clearly in dietary guidelines (Yates-Doerr 2015).

Research shows that food safety is a common worry but it can underestimate the significance of traditional food culture, nature conservation, potential economic development and food security. Consequently, entomophagy should be perceived holistically and elaboration of prospect legislation must take into account its multidimensional picture. (Halloran, Vantomme et al. 2015)

Van der Spiegel *et al.* (2013) states that some of the major obstacles to the advance of an edible insect sector are the use and trade of insects as both animal feed and food and the absence of a comprehensive legislation that governs the production (van der Spiegel, Noordam et al. 2013).

As an answer to the rising amount of enterprises commercially exploiting the growing demand for insects as food, Thailand has been trying to regulate insects as food. Yet, supplementary stock of insect species is received from other countries (such as Lao PDR) since the demand for certain insect species is so vast that national production cannot be met (Yates-Doerr 2015) .

This could impose nature conservation laws less strictly. For instance, Thailand and Kenya can illustrate that fulfilling the interests of various investors may be a challenging task. In Western countries, several local and national governments have governed the gathering of wild foods (e.g. mushrooms) and the equivalent can be accepted for insects. As is the case of Thailand, regulation of wild harvesting as well as semi-domestication of farmed insects has been stimulated in order to inspire sustainable diets and food security (Halloran, Vantomme et al. 2015).

In terms of formalization of local economy, there is a shortage of legal framework governing insects as food in Kenya and Thailand. Conversely, this is not a main obstacle to the development of the insect food sector. In those countries where entomophagy is a common practice, insects as food have always been a part of the informal economy. Contrarily, in western cultures, where entomophagy has not been a constituent of food culture, their corresponding governments did not have the precaution to anticipate the future necessity to integrate insects into legislation. For this reason, there is frequently little control of this resource (Mlcek, Rop et al. 2014).

On one hand, local informal economy can be threatened by formalization through regulation. On the other hand, it offers income and employment, particularly in places where unemployment levels are very high. Informality gives economic opportunities to the underprivileged, where the majority will certainly not be able to incorporate the expenses of formalization and also because it gives others a low cost scenario for trialing that can direct to business development (Belluco, Losasso et al. 2013).

Research suggests that Microbiological safety, toxicity, pathogens and insect diseases should also be acknowledged in this novel sector and a stronger link among natural science and policy making has to be established in order to certify safe processing methods and production (Rumpold and Schluter 2013). Entities such as the European Commission are currently investigating how to frame legislation (van Huis 2013).

Microbiological quality of food in particular has been a frequently discussed topic among researchers. Mainly because there are a variety of traditionally different methods to cook and eat insects but frequently they are eaten as whole, including their gut microflora (which can disturb the microbiological quality of food) (van der Spiegel, Noordam et al. 2013).

A recent exploratory evaluation of the microbiological material of processed, stored and fresh edible insects was carried out with emphasis on farmed house crickets (Acheta domesticus) and mealworm larvae (Tenebrio molitor). As observed, brief heating phase was enough to remove Enterobacteriaceae, yet a few sporeforming bacteria will outlive in cooked insects. Simple conservation methods, without use of a refrigerator, such as drying/acidifying were verified and reflected as favorable. Lactic fermentation of composite flour/water mixtures comprising 10, or 20% powdered roasted mealworm larvae resulted in effective acidification and was proven efficient in protecting safety and shelf life by the control of bacterial spores and Enterobacteria (Klunder, Wolkers-Rooijackers et al. 2012).

Proof of allergenic components in insects is available and seems to be similar to allergies of consuming crustaceans (van der Spiegel, Noordam et al. 2013). Research also suggests that attention should be also called for people allergic to house dust mites, mollusks or shellfish (Barre, Caze-Subra et al. 2014).

Besides allergies related to consuming insects, research also calls attention to a few incidents of allergies due to interaction with insects used as feed. For instance, Protein Contact Dermatitis, a condition triggered by a various insects as a consequence to sensitivity to insect proteins has been described among anglers and zookeepers (Wilkinson, Fregert et al. 1970, Camarasa and Serra-Baldrich 1993, Virgili, Ligrone et al. 2001, Usamentiaga, Rodriguez et al. 2005). The clinically described signs of this allergy are chronic eczema with episodic acute urticarial or vesiculous exacerbation appearing in minutes after contact with the allergen (Bregnbak, Friis et al. 2014).

Due to the absence of knowledge when it comes to consuming insects and the possible adverse health effects and standardization of rearing methods, Switzerland has engaged a protective attitude towards addressing insects as food and feed. Comparable to Switzerland, Kenyan legislation has also adopted a defensive attitude when it comes to addressing insects as food and feed. Contrarily, Canada handles food safety matters in terms of the sanitary standards of the places dealing with food products. Thus, insects are handled in the same way as the majority of other food products. A similar attitude happens in Thailand (Halloran, Vantomme et al. 2015).

In the Netherlands for example, numerous feed companies have committed to incorporate insects in their livestock feed and have everything arranged and ready to launch once the EU legislation permits to do so (Mlcek, Rop et al. 2014). Still, there is no prediction about the way stakeholders, citizen/consumers and farmers will react to the use of insects in animal feed (Verbeke, Spranghers et al. 2015).

These reactions will possibly define the potential success of the use insect-based feed for distinctive species and the marketplace approval of foods that comes from animals grown on insect-based feed. Although studies have revealed that the approval of insects and insect-based foods by consumers cannot be underestimated (Lensvelt and Steenbekkers 2014, Megido, Sablon et al. 2014, Verbeke 2015, Verbeke, Spranghers et al. 2015). At present, there is not enough knowledge regarding the intentions to embrace insect-based feed in livestock production and the subsequent livestock products (Verbeke, Spranghers et al. 2015). There is also not enough knowledge when it comes to the acceptance of insects as food and feed by prospect consumers and sellers.

2.1.5 New Trends

Although entomophagy is still a practice most common in some African, Asian, South and American countries, it is slowly spreading to some European countries and USA (Megido, Sablon et al. 2014). Still remaining very limited, mainly for psychological reasons, entomophagy is emerging with companies dedicated to mass production of edible insects and the opening of restaurants focusing on presenting menus containing insect based dishes (Barre, Caze-Subra et al. 2014).

In general, there are three most common ways in which insects are consumed. Firstly, insects can be eaten as whole, identifiable as such; secondly, whole insects are processed into paste or powder; thirdly, insects can be eaten as an extract (e.g. protein isolate) (Klunder, Wolkers-Rooijackers et al. 2012). In many developing countries, whole identifiable insects are frequently eaten as a fried snack or as portion a meal, for example, with rice. Boiled or live insects as well as ready-to-eat insect dishes are frequently sold at local markets (Melo-Ruiz, Sanchez-Herrera et al. 2013).

In a non-identifiable version, insects are processed into a dried form (e.g. insect powder). In this case, the whole insect is dehydrated and ground-up. This flour can be added to many food products from energy bars to cereals. Furthermore, it can be incorporated in various suitable for protein enrichment foods of a diversity of low-nutrient feed or foods (Melo-Ruiz, Sanchez-Herrera et al. 2013).

For instance, suggestions have been made for the application of boiled, roasted or ground up termites (Macrotermes spp.) to enrich sorghum; the nutritionally 'weak' grain, commonly consumed in various African countries, which is depleted in various essential amino acids (e.g. lysine) and is low in fats and proteins (Kazanas and Fields 1981).

The potential of using insect in the contemporary culinary is enormous (Mlcek, Rop et al. 2014). Gradually, food chefs are beginning to incorporate insects in some dishes and recipes. Australias' Witchety grubs are on the menu of the Sydneys' sophisticated Rountrees, and also on a growing list of other restaurants in Australia. According to some clients, the taste of *Xyleutes* (witchety grub), "when lightly cooked in hot ashes, would delight a gourmet" (MeyerRochow and Changkija 1997).

Globally, chefs, food entrepreneurs and researchers are being encouraged to further develop insect gastronomy in order to upgrade entomophagy (Kelemu 2015). New researches on new insect based food are starting to implement some very creative ideas including insect based cakes, cookies and desserts in general (Pascucci and de-Magistris 2013).

For instance, a recent study analyzed the extraction of the gelatine from 2 edible insects (C. viduatus and A. versicoloratus) and tried to apply it on ice cream. Gelatine is defined as product obtained by the partial hydrolysis of collagen derived from the skin, bones and white connective tissue of animals (Berillo and Volkova 2014). The properties of the obtained ice cream were expressively similar when compared to the ice cream made by commercial gelatine. The study concluded that ice cream resultant from gelatines from insects is a viable and more economical solution (Mariod and Fadul 2015).

There are currently available insect cookbooks, featuring many creative insect based dishes. Among them: Entertaining with Insects, The Insect CookBook, Eat-a-bug CookBook, Bugs for lunch, Creepy Crawly Cuisine, Man eating bugs: The art and science of eating insects (Ballantine 2000). It has been suggested that in the near future, gastronomy will play an important part in shaping our ideas about insects as food (Megido, Sablon et al. 2014).

2.2 Consumers' Acceptance

Since the publication of Insects as Human Food in 1951 (Bodenheimer 1951), a significant progress has been made in mapping the consumption of edible insects around the world (Tuorila and Monteleone 2009, Chakravorty, Ghosh et al. 2011, Meyer-Rochow and Chakravorty 2013). Still, consumers' acceptance needs to be established and, consequentially, more work is needed to further this progress (Kim, Ebesutani et al. 2013, Lensvelt and Steenbekkers 2014, Megido, Sablon et al. 2014, Nadeau, Nadeau et al. 2015). The utilization of insects in modern and traditional diets has opened a door for an interesting discourse on how consumers in different parts of the world perceive insects and whether or not they accept the idea of consuming them (Martins and Pliner 2005). Scientific research has shown that the acceptance of a certain food can be controlled by cultural, personal and emotional factors (Verbeke 2015).

Regardless of some new trends, insects have always been involved with the idea of disgust and fear by people from developed countries (Lensvelt and Steenbekkers 2014), and the difference between edible or inedible products is essentially based on culturally transmitted information (Megido, Sablon et al. 2014). Although insects are very popular among some developing cultures, the thought of eating an insect can be very disturbing for many people in developed countries (Srivastava, Babu et al. 2009).

There is a pronounced similarity in the attitudes and understanding of many people in the Western world regarding the value and place of invertebrate animals, especially insects, in our environment and diet (Looy, Dunkel et al. 2014). It has been suggested that a large amount of Westerners seems to aggregate terrestrial arthropods into one large homogeneous group called ''bugs'' and treat nearly all of them as possible threats (Deroy 2015). Furthermore research shows that the American public, including American farmers, view most terrestrial invertebrates ''with attitudes of antipathy, fear, and aversion'' (Kellert 1993).

Most of our existing media (television, books, videogames and movies) suggests and communicates this aversion (Deroy 2015). This repulsion to invertebrates involves the conviction that these species are disgusting and are mostly inedible by humans, except under the most desperate of circumstances, such as a starvation point. This attitude is unique both historically and cross-culturally (Illgner and Nel 2000).

It has been proposed that we may be 'biologically prepared' to fear this type of animal as an adaptive mechanism (Looy, Dunkel et al. 2014). As only a few species between wasps, scorpions, spiders and bees are actually dangerous to humans, a bite even if not deadly is certainly unfriendly, so that insect phobias and fears are always in the people's minds (Berenbaum 1995). Furthermore, since urbanized Westerners can only make a few realistic distinctions among ''bugs'', this easily generated anxiety may have led us to include mostly all insect species into one word "bug" (Ohman 1986).

It has been suggested that implicit negative associations and attitudes toward insects affect our responses and preferences for neutral events, objects, and people even when we are unaware of the presence of insect-related stimuli (Greenwald, McGhee et al. 1998). We are almost never stimulated to view insects as fundamental participants in the ecology that supports all of us or as engaged in relationships that allow other animal species and plant to prosper. In most cases, we are equally indifferent to invertebrate extinctions, despite the fact that their disappearance would be disastrous to our existence (Kellert 1993, Looy, Dunkel et al. 2014).

Unfortunately, most of the time the management of our life excludes insects from our physiological and physical contact, making them ignored from our lives in general. For instance, insects are uninvited guests at our tables, hovering nearby, crawling on our food (Loo and Sellbach 2013).

There is clearly a history of public, political, and scholarly resistance to a serious consideration of insects as human food (DeFoliart 1999), which is unfortunate since the Westerns should start accepting the idea of insects as viable source of food, or public health and the environment will rapidly suffer undeniable consequences (Lindeman and Vaananen 2000, Belluco, Losasso et al. 2013).

Consumers´ acceptance of entomophagy has been recently explored in Australian and Dutch populations, providing an insight into which factors are effective to influence consumers´ acceptance of entomophagy. It has been concluded that information about entomophagy and offering the participants with the chance to try insect food, both seem to be equally significant when trying to positively stimulate their attitude towards entomophagy (Lensvelt and Steenbekkers 2014).

The identification of consumers' understanding of insects and their incorporation into diet, as well as the evaluation of consumers' acceptance of insects as food or feed has also been recently analyzed. Consumers mainly associated "insects" and "insects and diet" with feelings of disgust, repugnancy, horror and fear and strong negative emotions. In opposition, other consumers associated "insects" directly with insect characteristics and with non-insects, such as spiders; they also associated "insects and diet" with food and diet, geography and culture (mainly from Asian countries), and insect characteristics (Cunha, Moura et al. 2014).

Research has also investigated acceptance of insects as animal feed lately in Belgium. Attitudes regarding the idea of using insects in animal feed were commonly positive, particularly for poultry and fish feed. In general, the findings of this research suggested a positive momentum and atmosphere for shift towards the acceptance of insects as a new ingredient in animal feed (Verbeke, Spranghers et al. 2015).

When it comes to animal feed, the use of insect is a prospective path to increase the sustainability of animal diets and meet the increasing global requirements for livestock products (Makkar, Tran et al. 2014). Yet, little is known about the willingness-to-accept and attitudes towards insect-based animal feed and foods.

In this sense, the subject of novel foods' acceptance is very promising and yet it has not been given the appropriate attention. Further research is needed regarding its acceptance in order to persuade Western culture of the value and benefits of using insects as food and feed (Martins and Pliner 2005). Moreover, "educating" consumers about entomophagy must be practiced in its widest sense in order to broad its acceptance (Lensvelt and Steenbekkers 2014, Nadeau, Nadeau et al. 2015).

2.2.1 Sushi Acceptance

At first, insects may not seem appealing to Westerns but neither did sushi a few decades ago. The primary repulse towards a specific food can be changed into a preference, it depends on the personal familiarization and acceptance of something new, and such is the case of sushi (van Huis 2013). When sushi was first introduced to westerns, it was considered a strange and rather peculiar way of eating fish; the idea of eating uncooked fish was quite repulsive to people (Feng 2012). Within years, a process of familiarization took place and sushi is now a massive reflection of the globalization and it is now defined as modern delicacy (McInerney 2007).

As a contemporary cuisine, sushi faced its most intense and dramatic expansion and transformation in the 20th century (Jeong, Oh et al. 2014). By this time, Japanese cuisine became one of the most prevalent selections when people wanted to choose to a restaurant. For example in the U.S., between 1988 and 1998, the number of sushi restaurants quadrupled, followed by an even faster growth during the following years (Feng 2012).

Despite the significant efforts of revolutionary restaurant owners that perceived the gradual acknowledgement and acceptance of the sushi niche in the world, one of the critical moments in the increase of sushi as a popular cuisine was marked by its appearance in supermarkets all over America, Canada and United Kingdom (McInerney 2007). By this time, it was noticeable how the sushi went from a strange new version of eating fish to a remarkable preference between consumers in different parts of the world (Gilbert 1984).

In this sense, sushi is a perfect illustration of how food preferences can change over time and are not essentially stable. This transition from an aversive food into a preference suggests that edibles insects can be equally viewed as a potential food source among western societies (van Huis 2013). Still, more research on its acceptance is needed in order to allow western societies to have a broader diversity in terms of food sources, which will, consequentially bring great positive impacts to our health and environment (Lensvelt and Steenbekkers 2014).

2.2.2 The Disgust

A multitude of personal, affective, situational, and cultural aspects regulates the development and maintenance of novel food acceptances (Barrena, Garcia et al. 2015). A categorization of motives underlying food rejections has been established and it has been suggested that the negative extremes of two of the motivational dimensions are polar opposites of the primary factors underlying food acceptance (Rozin and Fallon 1987). In other words, the rejection of foods occurs if they are acknowledged to provide harmful effects, in either (or both) long or short term (Haidt, Mccauley et al. 1994). For instance, if they are bad for you; frequently mentioned as rejections based on 'danger' or if they are considered to have negative sensory properties such as smell, bad taste, appearance or texture; frequently mentioned as rejections based on 'distaste' (Haidt, Rozin et al. 1992).

As individuals' beliefs about these properties distance from these negative poles in the direction of the positive poles of these dimensions (i.e. 'taste good' or 'are good for you', respectively), foods are gradually likely to be accepted (Rozin and Haidt 2013). Positive transvaluation, is believed to promote food acceptance through the conviction that the positive properties of the food substance will in some way be transferred to the consumer (Goetz, Cougle et al. 2013). For instance, research shows that in South Indian temples, certain foods are approached as spiritual offerings to the gods; after these foods have been 'consumed' by the gods, the remains are given back to the believers. To be permitted to eat these remains is perceived as an honor; it makes them feel spiritually closer to the gods and reifies the cooperative nature of the relationship among gods and men (Appadurai 1981).

Rozin and Fallon's taxonomy of motives for food rejection also recognizes a third dimension in which its negative pole is termed disgust. This is the opposite pole of positive transvaluation and it is based on the awareness of the origin or nature of the substance (i.e. named the 'ideational' dimension) (Haidt, Mccauley et al. 1994).

In this sense, disgust is a refusal based on ideational properties; foods are rejected because of their origin, what they are, or their social history (e.g. who consumed or touched them) (Martins and Pliner 2005). It has been suggested that humans do not like to accept that they are animals and that disgust is a way to avoid the evidence of our animal nature (Rozin, Haidt et al. 1999). No universal disgust elicitors have been recognized in terms of foods. Contrarily, what is understood as disgusting, in terms of foods, is normally culturally bound. In other words, foods that can be contemplated as desirable foods in one culture can commonly bring a disgust response from people of different cultures (Kim, Ebesutani et al. 2013). As, for instance, the eating of dog meat or insects are frequently perceived as disgusting in many Westernized cultures (Goetz, Cougle et al. 2013).

The feeling of disgust plays an important part in socialization as many of the sensitivities of civilization and culture are reinforced by disgust responses (Rozin, Taylor et al. 2005). It is a significant emotion in our daily life, frequently involved when people withdraw from feeling or thinking of offensive situations (Rozin, Haidt et al. 1999).

It has been suggested that the centrality of food in disgust is supported by (1) ‘‘disgust’’ itself suggests ‘‘bad taste’’, (2) the facial expression characteristic of disgust accomplishes oral expulsion of foods (and is very similar to the distaste face), and (3) nausea and gagging, both of which discourage eating, are the physiological actions related to disgust (Rozin, Taylor et al. 2005).

Responses to disgusting things are so powerful that disgust frequently generalizes to entities that are not essentially disgusting, but look like disgusting. For instance, people feel disgusted near objects like mucuslike liquid, even though they know the objects are not what they appear (Rozin and Haidt 2013). This reaction illustrates the sympathetic law of *similarity,* which holds, in one form, that appearance is reality (van Overveld, de Jong et al. 2010).

It is proposed that disgust could be assumed as a way of dealing with an intensifying set of threats (Rozin, Taylor et al. 2005). Yet, the nature of disgust and its extension to social practices is quite incognito in the Western cultures over the past thousand years, and across cultures at the present time (Rozin and Haidt 2013). Research points out that cultural evolution, in particular, seems to be playing a major part in the expansion of disgust (Goetz, Cougle et al. 2013).

Fear and disgust of food insects, in particular, have been identified as barriers to the maintenance and restoration of traditional foods (Illgner and Nel 2000, Looy, Dunkel et al. 2014). The resistance of consuming insects has been recently investigated based on survey responses of nearly 200 Indian adults and 200 American adults. When asked an open-ended question about why they reject insects as food, the majority of respondents in both countries indicate "disgust" (Rozin 2014).

Behavioral research conducted in American students showed that a small majority of participants agreed to touch insects with their hands, but when they were asked to touch insects with their lips, a large majority refused (Rozin, Haidt et al. 1999).

Although the nature of the disgust has been explored throughout the years (Fallon, Rozin et al. 1984, Rozin 1985, Rozin and Fallon 1985, Rozin and Vollmecke 1986, Rozin and Fallon 1987, Haidt, Rozin et al. 1992, Rozin, Lowery et al. 1994, Rozin, Haidt et al. 1999, Rozin, Taylor et al. 2005, Rozin, Fischler et al. 2006, Rozin and Haidt 2013, Rozin 2014), little is known about the relationship between the acceptance of novel foods and the disgust (Rozin, Fischler et al. 2006).

One suggestion that has been made in order to have a deeper understanding regarding the relationship between the disgust and rejected foods is to reduce individuals' perceptions of the disgusting properties of these foods by emphasizing the opposite positive pole, positive transvaluation, of the Ideational dimension (Rozin, Taylor et al. 2005). Previous studies have effectively showed that emphasizing the opposite pole of the Sensory-Affective and Anticipated Consequences dimensions have occasioned in improved readiness to try foods previously rejected (Pelchat and Pliner 1995, McFarlane and Pliner 1997). Still this strategy has not been tested with foods rejected on the basis of disgust. Nevertheless, before this suggestion can be examined, scientists should first recognize what it is about foods that make them disgusting, and decide if the individual features of foods that are determined as disgusting are alike for non-animal and animal foods (Martins and Pliner 2005).

2.2.3 Food Neophobia

When a new food product is presented to a culture, it usually brings feelings of fear and rejection called neophobia (Pauperio, Severo et al. 2014). Food neophobia, has been defined as a reluctance to eat unfamiliar foods (Ritchey, Frank et al. 2003). Moreover, it is considered an individual personality trait, which impacts food choices and therefore food acceptance and consumption (Pauperio, Severo et al. 2014). Food neophobia has been considered as the tendency of the individual to approach or avoid novel foods (Cadete, Cunha et al. 2010). Western attitudes towards food have been commonly characterized by the rejection of certain food sources for psychological rather than logical reasons (DeFoliart 1999, Belluco, Losasso et al. 2013).

Food neophobia has been considered to affect both the quality and variety of foods in the diet, since we can potentially ingest a broad variety of foods and we tend to both avoid and approach unfamiliar foods (Ritchey, Frank et al. 2003). Throughout human evolution, both tendencies neophobia and neophilia had its adaptive significance (Fernandez-Ruiz, Claret et al. 2013). Neophilia amplified the prospect that we would consume foods from a diversity of sources, providing a broader possibility that nutritional necessities would be met. In other hand, neophobia had a function of protecting the individual from ingesting possibly toxic or nutritionally inadequate foods (Martins and Pliner 2005).

In non-humans, social context has been addressed as one of the elements that increase the acceptance of novel foods and, consequentially, decreases food neophobia (Musiani and Visalberghi 2000). Research has shown that tufted capuchins, Cebus apella, eat considerably more of novel foods when accompanied by group members eating the same novel foods (Visalberghi and Addessi 2000). Moreover, experiments with primates have suggested that when group members were present and consuming food, regardless of what group members were eating, there was a substantial rise in the acceptance of the foods (Rothman, Raubenheimer et al. 2014).

In humans, food neophobia has also been explored. In 1992 the Food Neophobia Scale (FNS) was developed. It is a 10-item verbal instrument, (Table 4) that is used to quantify neophobia in individuals (Pliner and Hobden 1992). The FNS is usually applied to predict willingness to try new foods (Fernandez-Ruiz, Claret et al. 2013).

1. I am constantly sampling new and different foods
2. I don't trust new foods
3. If I don't know what a food is, I won't try it
4. I like foods from different cultures
5. Ethnic food looks too weird to eat
6. At dinner parties, I will try new foods
7. I am afraid to eat things I have never had before
8. I am very particular about the foods I eat
9. I will eat almost anything
10. I like to try new ethnic restaurants

Each item has a seven-point Likert response set: disagree strongly, disagree moderately, disagree slightly, neither disagree nor agree slightly, agree moderately, and agree strongly.

Figure 1- Food neophobia scale (FNS). Source: Pliner and Hobden (1992)

Since then, the FNS has been translated and validated in Spanish population (Fernandez-Ruiz, Claret et al. 2013), Brazilian population (Previato and Behrens 2015), Portuguese population (Cadete, Cunha et al. 2010). It has also been applied in pregnant women (Pauperio, Severo et al. 2014) and in Italian primary school children (Laureati, Bergamaschi et al. 2015).

The Portuguese translated version of FNS has been applied to a random selection of 120 consumers. It was concluded that, in general, the panel presented a low neophobia results. Moreover, cluster analysis based on FNS produced 3 groups with the most neophilic group presenting a considerably higher education level and the most neophobic group being older (Cadete, Cunha et al. 2010).

It has been suggested that food neophobia impacts food diversity and, consequentially, diversity in nutrient intake. Study on neophobic vs. non–neophobic children concluded that neophobic children lack diversity in their everyday food ingestion, having a higher ingestion of saturated fats, and, generally, a poorer dietary quality (Falciglia, Couch et al. 2000).

Likewise, evidence has shown that food neophobia is related with lower ingestion of fruit, meat and vegetables in children (Cooke, Wardle et al. 2003). Still, most of the investigation on food neophobia is concentrated on the recognition and development of techniques to suppress rejection of novel foods. Undoubtedly, studies on rejection of novel foods tell us, theoretically, about the factors that contribute to acceptance of these foods. Still, there is little research on detecting the factors that contribute to acceptance of unfamiliar foods. Furthermore, most of the recent studies on food acceptance still concentrate on familiar foods (Martins and Pliner 2005).

2.2.3.1 Food Neophobia and entomophagy

In the case of entomophagy, neophobia has been described by the two hypotheses: the first is the refusal of insects because of the knowledge of their origin and habitats, and the second is the refusal of insects due to the anticipated negative post-ingestional consequences (Megido, Sablon et al. 2014).

The perception of entomophagy in individuals has been recently examined within the Belgium population. A slight neophobia was detected among the participants, but people agreed to evaluate insect preparations. Various insect formulations (mealworms and house crickets) were prepared, and insects' formulations with crispy textures and known flavors were favored among the others. People appeared to be willing to cook and eat insects in the future. It was also positively concluded the prospect to introduce entomophagy in food habits of Western populations (Megido, Sablon et al. 2014).

Although there has been a positive prospect in terms of entomophagy in food habits of Western populations, there is still very little research on the relationship between food neophobia and entomophagy (Rozin 2014) and, consequently, more research is needed in order to further the knowledge on this subject.

2.2.4 Food Choices

The choice of whether to consume a particular food is determined not only by the composition of that food, but a variety of causal factors and their interactions including the consumer's nutritional state and the compositions of alternative foods (Raubenheimer and Rothman 2013), the relationships of the food with the nutritional requirements of the consumer (Oftedal 1991), and cultural norms (Turner and Thompson 2013).

Research into food choices investigates how people select the food they eat, how to understand human behaviors related to food and the motivators behind food choices (Mazzonetto and Fiates 2014). There has long been a substantial interest in understanding consumers' food choices, where a key complexity in this context is the potentially large amount of heterogeneity in tastes across individual consumers, as well as the role of underlying attitudes towards food (Roberto and Khandpur 2014). What is behind food choices is what really are people's motivations, preferences and habits. Food choices are complex as well as frequent (O'neill, Hess et al. 2014). For instance, it has been estimated that a person can make over 200 foods and beverages related decisions every day (Wansink and Sobal 2007).

In a food context, the consumers' perception of wellbeing can also affect food choices. A cross-cultural study conducted in Brazil, France, Spain, Portugal and Uruguay has recently analyzed the consumers' association with wellbeing in a food-related context. Among other techniques, words associations were used to comprehend consumers' perception of dissimilar products and concepts. It was concluded that consumers' association with food-related wellbeing was particularly related to dietary recommendations and physical health associations (Ares, Saldamando et al. 2014) .

Research shows that when asking individuals to specify why they choose the foods they do, the majority of the motives most frequently mentioned are sensory/pleasure factors (principally taste) and healthiness (Rappoport, Peters et al. 1992, Hasegawa, Sakai et al. 2008). For instance, when Rappaport et al. (1992) inquired participants to describe the foods they had consumed in the past few days and to specify why they had chosen to consume these foods, two reasons were most cited: sensory/pleasure or health (Rappoport, Peters et al. 1992). Additional support for the significance of these factors in everyday food choices comes from one measure: the Food Choices Questionnaire (FCQ) (Steptoe, Pollard et al. 1995), which assesses the motivations underlying individuals' everyday food choices.

The FCQ is a tool that had originally 36 items which allows researchers to assess nine distinct food choice motives, among them: health, mood, convenience, sensory appeal, natural content, price, weight control, familiarity and ethical concern. Since then the FCQ has been successfully applied in several scientific studies, such as using it to explain variations in dietary intake (Pollard, Steptoe et al. 1998).

A research conducted in Finland developed three complementary scales to the FCQ. The suggestion was that one important domain which is underrepresented in FCQ is food choice based on ethical reasons. The Ethical Concern subscale of FCQ includes three items, one of which addresses political approval of the country of the food's origin, one labeling the country of the food's origin, and one environmental protection. In this sense, a more detailed measurement of ethical food choice was developed. The new items address various ethical food choice motives and were derived from previous studies ethical food choice. The results indicated that the three new scales (8 new items), Ecological Welfare (including subscales for Animal Welfare and Environment Protection), Political Values and Religion, are reliable and valid instruments for a brief screening of ethical food choice reasons (Lindeman and Vaananen 2000).

The FCQ has been validated in various countries including USA (Pula, Parks et al. 2014), Belgium, France, Italy, Norway, Poland and Spain (Pieniak, Perez-Cueto et al. 2013), Croatia, Bosnia, Macedonia, Slovenia, Serbia and Montenegro (Milosevic, Zezelj et al. 2012), Belgium, Hungary, Romania and Philippines (Januszewska, Pieniak et al. 2011), Greece (Fotopoulos, Krystallis et al. 2009), Russia (Honkanen and Frewer 2009), Uruguay (Ares and Gambaro 2007), Canada, Belgium and Italy (Eertmans, Victoir et al. 2006), Japan, Taiwan, Malaysia and New Zeeland (Prescott, Young et al. 2002). The FCQ has also been translated (Cadete, Cunha et al. 2010) and applied (Cadete, Cunha et al. 2010) to Portuguese population. Recently the validity and reliability of the FCQ has been also tested in 9 different European countries, including Portugal (Markovina, Stewart-Knox et al. 2015). It has been suggested that the FCQ is an appropriate tool for exploring food choice motives across different European populations (Markovina, Stewart-Knox et al. 2015).

Regarding its application, suggestions have been made such as differences in relative importance of factors within countries may need to be taken into account in dietary health intervention and food product development (Markovina, Stewart-Knox et al. 2015).

The ability to influence food choices is critical to society, and it can impact health problems, such as obesity, to environmental problems by promoting sustainable food choices (Rodriguez-Oliveros, Bisogni et al. 2014, Schonberg, Bakkour et al. 2014, Stehfest 2014, Sundberg, Augustsson et al. 2014). Experts agree that diets have to change or adapt into a more sustainable direction due to the fact that the food production, especially meat, is one of the main pressures on the environment at the moment (Thorndike, Riis et al. 2014). Experts also agree that adopting more sustainable choices seems to be a reliable solution to this issue (Vogel 2010, Melo-Ruiz, Sanchez-Herrera et al. 2013, van Huis 2013, Machovina and Feeley 2014, Stehfest 2014).

2.2.4.1 Sustainable food choices

Research on sustainable food choices investigated whether Self-Determination Theory (SDT) can be of help in fostering more sustainable food choices, including insects, by taking a closer look at the relationship between food-related types of motivation and different aspects of meat consumption, based on a survey among 1083 consumers in the Netherlands. SDT appeared to be useful for studying why consumers can be motivated to make more sustainable food choices and also why all consumers do not share these preferences. Internalized motivation was the main factor that made a difference, but intrinsic enjoyment of cooking and eating also played a role. The conclusion is that SDT provides both theoretical and policy-oriented insights into fostering more sustainable food choices (Schosler, de Boer et al. 2014).

A recent survey among 221 Flemish respondents investigated consumers’ opinions towards a series of food choices with a lower ecological impact. The investigated food choices range from well-known meat substitutes to alternatives which are more radical or innovative and that require an adaptation of food habits and cultural patterns. The evaluation of hybrid meat products and plant-based meat substitutes received a rather neutral to slightly positive evaluation score. On the contrary, the consumption of protein from insects received a pronouncedly negative evaluation score. The uncertain seemed to be rather averse or skeptic towards the more innovative alternatives such as hybrid meat types and protein from insects. Given that insects are a popular delicacy in some Asian and African countries (Vogel 2010), the refusal of the samples offered (and by elaboration the Western society) seemed to be culturally motivated (Vanhonacker, Van Loo et al. 2013)

Although recently the research on food choices has been focusing its attention on alternative sustainable food choices, still very little research has explored the relationship between the consumption of insects as alternative food choices. In this sense, more research on this subject is needed, especially because we are in a point in time where the production of sufficient poultry, fish and livestock represents a serious challenge for the future (Nadeau, Nadeau et al. 2015), generating a variety of environmental problems which will soon start affecting food security in a global scale (Halloran, Vantomme et al. 2015).

3 Materials and Methods

The present study is a continuation of previous studies (Cunha, Moura et al. 2014) on insect consumption and acceptance. It is a cross-cultural study performed in two countries: Portugal and Norway. The main objective of this study is to evaluate the determinants of consumers' acceptance of insects as food and feed. Some specific objectives are: (1) To characterize different consumers' segments regarding their acceptability of insects as food and feed; (2) To evaluate the relationship between the insects' acceptance as food and feed and food neophobia, disgust level, and other psychographic or personality traits; (3) To draw a cross-cultural study comparison on the acceptance of insects as food and feed within western cultures. To investigate determinants of consumers' acceptance of insects as food and feed a survey methodology was used.

3.1 Questionnaire and Scaling

The questionnaire was initially prepared in English by the Portuguese research team where the author of this dissertation is included in Portugal. After discussion, a final version was approved and then translated to the each country's languages. When previously applied, the translated versions of the different items were available. Those were used and the rest was translated by the each country research team, based on their expertise and following a translation-back translation procedure process (Brislin 1970). The questionnaire had 8 questions, comprising anchored scales (7-point), open-ended questions, multiple-choice questions, and a socio-demographic module. The questionnaire included the following dimensions:

- The FCQ (Steptoe, Pollard et al. 1995), describing particular dimensions, which has been translated and applied to the Portuguese population (Alves, Cunha et al. 2005, Cunha, Moura et al. 2007). The importance of health for participants when making food choices was measured using 6 items:
    - "Contains a lot of vitamins and minerals";
    - ”Keeps me healthy”;

- "Is very nutritious";
- "Is high in protein";
- "Is good for my skin/teeth/hair/nails etc";
- "Is high in fiber and roughage".

Each items was scored in an anchored 7-point scale, ranging from 1= Not important to 7= Very important. The 6 items were chosen to measure the health food choice score (FCQ-Health).

The importance of convenience for participants when making food choices was measured using 5 items from FCQ. The 5 items were:

- "Is easy to prepare";
- "Can be cooked very simply";
- "Takes no time to prepare";
- "Can be bought in shops close to where I live or work";
- "Is easily available in shops and supermarkets".

Each items was scored in an anchored 7-point scale going from 1= Not very important to 7= Very important. The 5 items were merged into one Convenience Food Choice (FCQ-Convenience) score.

Ethical food choices and ecological welfare (Lindeman and Vaananen 2000), also translated and applied to Portuguese population (Alves, Cunha et al. 2005, Cunha, Moura et al. 2007). The importance of ethical food choices and ecological welfare was measured using 5 items:

- "Has been produced in a way that animals have not experienced pain";
- "Has been produced in a way that animals' rights have been respected";
- "Has been prepared in an environmentally friendly way";
- "Has been produced in a way that has not shaken the balance of nature";
- "Is packaged in an environmentally friendly way".

Each items was scored in an anchored 7-point scale ranging from 1= Not important to 7= Very important. The 5 items were merged into one Ecological Welfare Food Choice (FCQ-EW) score.

- Food Neophobia Scale (FNS) (Pliner and Hobden 1992), translated (Cadete, Cunha et al. 2010) and applied to Portuguese population (Cadete, Cunha et al. 2010). Food neophobia of participants was measured using six items selected from the (FNS). The six items were:

  - "I am constantly sampling new and different foods" (R – reverse coded);
  - "I don't trust new foods";
  - "If I don't know what is in a food, I won't try it";
  - "At dinner parties, I will try a new food" (R);
  - "I am afraid to eat things I have never had before";
  - "I will eat almost anything" (R);

The selection of these six items was primarily informed by the six-item food neophobia model proposed by Ritchey *et al.* (2003), also adapted by Verbeke *et al.* (2015) when testing readiness to adopt insects as meat substitute in Western society (Ritchey, Frank et al. 2003, Verbeke 2015). Each item was scored in an anchored 7-point scale going from 1= strongly disagree to 7= strongly agree. The ten items were merged into one food neophobia score (FNS).

- Familiarity with eating insects. Participants were asked to indicate the level of familiarization with edible insects through a multiple-choice question. Six responses were included in this question. The following three responses were adapted from Verbeke (2015) to our multiple-choice question:

  - "Yes, I have heard of the eating of insects and I know what it means";
  - "I have heard of the eating of insects but actually don't know what it means";
  - "No, I have never heard of the eating of insects". (Verbeke 2015)

The other 3 responses were incorporated by the project to expand the options so that participants can have a broader set of choices:

  - "I have heard that a few insects are edible";

- "I have heard of the eating of insects in other cultures (i.e. African and Asian)";
- "I have heard of the eating of insects at some restaurants".

Participants were asked to place themselves in one or more responses that they would consider to fit them.

- Previous experience with edible insects. To measure the participants´ level of exposure to edible insects a multiple-choice question was designed. Five responses were developed:

  - "I´ve never tried edible insects",
  - "I´ve tried edible insects on a single occasion",
  - "I´ve tried edible insects on a few occasions",
  - "I eat edible insects seasonally"
  - "I eat edible insects regularly".

Participants were asked to choose only one response among the 5 options.

- Perceived acceptance of insects as food and feed and perceived acceptance of sushi. Participants´ levels of acceptance of insects as food and feed were measured using 7 items from Cunha *et al.* (2014). Participants were asked: "If someone offers you a meal or a snack based on:" and had to answer the 7 items:

  - "Edible insects";
  - "Pork from animals fed with feed incorporating insects or insect protein";
  - "Poultry from animals fed with feed incorporating insects or insect protein";
  - "Beef from animals fed with feed incorporating insects or insect protein";
  - "Fish from animals fed with feed incorporating insects or insect protein";
  - "Sushi";
  - "Protein bar with flour made out of cricket".

Participants were asked to place themselves in an anchored 7-points scale that ranged from 1= Totally accept to 7=Totally reject (Cunha, Moura et al. 2014).

- Disgust towards edible insects. To evaluate the level of disgust of participants; a question drawn from Rozin (2014), was used. Five responses were given as options to participants:

  - “The idea of insects makes me nauseous”,
  - “The idea of insects makes me ill”,
  - “Eating insects is disgusting”,
  - “I am offended by the idea of eating insects”
  - “If an insect crawls on my favorite food I won´t eat it”.

The question has an anchored 7-point scale ranging from 1= totally disagree and 7= totally agree (Rozin 2014)

- Knowledge of edible insects. To define the level of knowledge participants have towards edible insects, a free-listing format question was designed. Participants were asked to name, if known, up to four names of edible insects (Cunha, Moura et al. 2014).

- Socio-demographics. To access the socio demographic information of participants, ten questions were developed. They were divided into: Age, gender, marital status, maximum level of educational achievement, occupation, economic situation, nationality and place of residence.

3.2 Data collection and sample

In Portugal and Norway, the questionnaire was applied through a web-based survey. Portugal used the web platform *LimeSurvey* and Norway used *EyeQuestion.* It took an average of 10 minutes for the questionnaire to be responded. In both countries, the 16 items regarding health, convenience, ecological welfare and the 10 items from food neophoby scale, the 5 items from the disgust scale as well as the questions regarding the acceptance of the different forms of insect based foods were randomized. They were randomized compensate possible order effects (Kearney, Kearney et al. 1997). The questionnaire was applied during the months of February and June 2015.

In Portugal and Norway, a non-random convenience sample, structured by sex and age group was used (N=666). In Portugal and Norway participants were recruited through informal social networks and within the consumers database from *Sense Test* (a consumer and sensory market research company). In both countries, participants from different ages, gender, marital status, education level, occupation, economic situation were selected in order to attain a more heterogenic sample. The Norwegian database was sent back to Portugal for analysis.

3.3 Data analysis

In both samples data was transformed and recoded. Gender was recoded into 1= Female and 2= Male. To categorize age among participants, three age groups were created: [18; 35[, [35; 55[and 55+. Maximum level of educational achievement was divided into 2 groups: higher education and lower education. For both countries, the group lower education included: less than high school, high school, technical/professional degree, and some college/no degree. The group higher education included: graduate degree and post-graduate degree. These two groups were recoded into 0= low and 1= high. Economic situation was divided into 7 groups being 1= "very difficult" and 7= "well-off".

Calculation of the value of scales (scores) was performed for the constructs: *FCQ (health, convenience and ecological welfare), Disgust* and *FNS* and the following constructs were originated*: FCQ-Health, FCQ-Convenience, FCQ-Ecological Welfare, Disgust, FNS6 adapted.*

Additionally, the variable *previous experience* was recoded. The statement "I have never tried edible insects" became 0 and "I have tried edible insects on a single occasion", "I have tried edible insects on a few occasions", "I eat edible insects seasonally" and "I eat edible insects regularly" became 1.

The variable *familiarity* was also recoded. The statement "No, I have never heard of the eating of insects" and "I have heard of the eating of insects but actually don´t know what it means" became 0 and "Yes, I have heard of the eating of insects and I know what it means", "I have heard that a few insects are edible", "I have heard of the eating of insects in other cultures (i.e. African and Asian)", "I have heard of the eating of insects at some restaurants" became 1.

To describe the basic features of the sample, descriptive statistics was run (frequencies, mean and standard deviation).

Factor analysis was used to verify the unidimensionality of scales. The internal consistency of the different scales was evaluated using Cronbach´s alpha, which estimates reliability of scales. Cronbach´s -α is viewed as the expected correlation of two tests that measure the same construct (Feldt 1980). Alpha, conceived as internal consistency coefficient, is the most frequently used reliability coefficient in scientific research (Cho and Kim 2015). Cronbach´s alpha was applied globally and for each country separately.

Explained variance, where the principal component accounts for or "explains" the overall variability (Wiorkows 1970) was also performed. Kaiser-Meyer-Olkin (KMO) statistics was used to measure sampling adequacy; if data are likely to factor well, based on correlation and partial correlation (Kaiser 1981).

In line with Cunha *et al.* (2014), acceptance scores were compared using non-parametric tests (Mann-Whitney) (Cunha, Moura et al. 2014).

A hierarchical cluster analysis using Ward's method followed by a K-mean clustering was conducted (Hair, Anderson et al. 1998, Cunha, Moura et al. 2010, Cunha, Moura et al. 2014). Cluster analysis was applied based on the degree of acceptance of the different forms of insects as food (direct and indirect) to identify different consumer The segments identified were labeled as: *Disgusted* (C1), *Rejecters* (C2), *Feed acceptors* (C3) and *Acceptors* (C4).

Moreover, acceptance data was reduced through factorial analysis with *Varimax* rotation (Hair, Anderson et al. 1998), projecting the six variables into two factors: i) acceptance of insects as food and ii) acceptance of insects as feed. Factor scores were computed as the average of the variables expressing it. Considering consumers' acceptance of insects as food and as feed as a binary choice is consistent with the recommendation by Hoek *et al.* (2011), based on Wansink *et al.* (2004) who suggested using a dichotomous seeker/avoider segmentation when the product category under investigation is not frequently purchased and/or when there is a strong attitude towards the product category. Both conditions are clearly fulfilled for the case of acceptance of edible insects in Western countries (Wansink, Sonka et al. 2004, Hoek, Luning et al. 2011, Verbeke 2015). In line with that, acceptance of insects as food and feed was transformed into binary choice being 0= non-acceptance (factor scores between one and four) and 1 = acceptance (factor scores above four).

For the prediction of the binary acceptance of insects as food and as feed, application of binary logistic regression was executed for each of the countries, expressing acceptance as a function of FCQ-Health, FCQ-Convenience, FCQ-Ecological Welfare, disgust, FNS, familiarity, exposure, acceptance of sushi, gender, age and high education (Verbeke 2015).

All statistical tests were applied at 95% confidence level, except when stated otherwise. All data was analyzed using the software IBM SPSS Statistics for Windows V.23 ®.

4 Results

4.1 Sample characterization

In Portugal, 443 questionnaires were administrated and 303 were considered valid. In Norway, 456 questionnaires were administrated and 363 were considered valid. A total of 666 were validated within the participating countries. The Norwegian sample was comprised of 67.5% of women and 32.5% of men whereas the Portuguese sample was composed of 59.4% of women and 40.6% of men (see Table 4). Within the 3 age groups established by the project the majority of the Norwegian sample was concentrated within the age group [35; 55[, being 39.9%. The majority of the Portuguese sample was concentrated within the age group [18; 35[being 46.5% of sample. The average age for the Norwegian sample was 41.1 years (SD= 0.8) and 40 years (SD=0.9) for Portugal. The majority of participants in both samples were married, being 64.5% of the Norwegian sample and 51.6% of the Portuguese sample. In the Norwegian sample, 57.3% had a higher education. Contrarily, 52.1% of the Portuguese sample had a non-higher education. Considering the perceived economic situation of the Norwegian sample, 32.5% selected option 5, a median-high economic situation being 1 = extremely difficult and 7 = well off, and 45,5% of the Portuguese sample have selected option 4, a median economic situation.

Table 4 - Socio-demographic characteristics of the sample (N=666)

Characteristics	Norway (n=363)	Portugal (n=303)
Gender		
Female	245 (67.5%)	180 (59.4%)
Male	118 (32.5%)	123 (40.6%)
Age group		
[18;35[	136 (37.5%)	141 (46.5%)
[35;55[	145 (39.9%)	89 (29.4%)
55+	82 (22.6%)	73 (24.1%)
Age		
(Average ± st. dev.)	*41.1 (± 0.8)*	*40.0 (±0.9)*
Marital status		
Single	106 (29.2%)	97 (32.0%)
Married	234 (64.5%)	170 (56.1%)
Separated	20 (5.5%)	27 (8.9%)
Widow	3 (0.8%)	9 (3%)
Higher Education		
No	155 (42.7%)	158 (52.1%)
Yes	208 (57.3%)	145 (47.9%)
Economic situation		
1 - Very difficult	3 (0.8%)	7 (2.3%)
2	12 (3.3%)	29 (9.6%)
3	23 (6.3%)	71 (23.4%)
4	83 (22.9)	138 (45.5%)
5	118 (32.5%)	42 (13.9%)
6	83 (22.9%)	14 (4.6%)
7 - Well-off	41 (11.3%)	2 (0.7%)
(Average ± st. dev.)	*5 (± 0.1)*	*3.8 (± 0.1)*

4.2 Evaluation of constructs

To verify the unidimensionality of scale for the construct FCQ-Health, factorial analysis was computed (KMO, explained variance and Cronbach´s alpha) (see Table 5). The model explains most of the variability of the response data around its mean for Norway (55.8%) and Portugal (70.7%). Sampling adequacy was above acceptance being 0.867 for Norway and 0.895 for Portugal. A high internal consistency coefficient for Norway (α= 0.835) and Portugal (α=0.909) was also verified. Data shows that the FCQ-Health construct is unidimensional and consistent, with all six items presenting high loadings (>0.6), for both countries.

Table 5 - Factorial structure and consistency for the construct FCQ-Health, obtained for each country under comparison

	Norway (n = 363)			**Portugal** (n = 303)		
	Loadings	**Mean (±Std.error)**	**Value**	**Loadings**	**Mean (±Std.error)**	**Value**
FCQ-Health		4.9 (±0.0)			5.8 (±0.1)	
Contains a lot of vitamins and minerals.	0.830	5.1 (±0.1)		0.902	5.9 (±0.1)	
Keeps me healthy.	0.740	5.7 (±0.1)		0.807	6.3 (±0.1)	
Is very nutritious.	0.780	5.1 (±0.1)		0.870	6.0 (±0.1)	
Is high in protein.	0.654	4.4 (±0.1)		0.857	5.6 (±0.1)	
Is good for my skin/teeth/hair/nails etc.	0.680	4.3 (±0.1)		0.739	5.4 (±0.1)	
Is high in fiber and roughage.	0.783	4.6 (±0.1)		0.860	5.6 (±0.1)	
Explained variance			55.8%			70.7%
KMO			0.867			0.895
Cronbach's alpha			0.835			0.909

For the construct FCQ-Convenience, factor analysis was also run (KMO, explained variance and Cronbach´s alpha) to verify the unidimensionality of the scale (see Table 6). Sampling adequacy was above acceptance being 0.744 for Norway and 0.832 for Portugal. The model explained most of the variability of the response data around its mean for Norway (58.3%) and Portugal (72.1%). A high internal consistency coefficient for Norway (α= 0.813) and Portugal (α=0.903) was also verified. Data shows that for both countries the FCQ-Convenience construct is unidimensional and consistent, with all five items presenting high loadings (> 0.5).

Table 6 - Factorial structure and consistency for the construct FCQ-Convenience, obtained for each of the countries under comparison

	Norway (n = 363)			**Portugal** (n = 303)		
	Loadings	**Mean (±Std.error)**	**Value**	**Loadings**	**Mean (±Std.error)**	**Value**
FCQ-Convenience		4.9 (±0.1)			5.5 (±0.1)	
Is easy to prepare.	0.872	4.7 (±0.1)		0.870	5.5 (±0.1)	
Can be cooked very simply.	0.887	4.7 (±0.1)		0.906	5.4 (±0.1)	
Takes no time to prepare.	0.799	4.1 (±0.1)		0.899	5.3 (±0.1)	
Can be bought in shops close to where I live and work.	0.574	5.7 (±0.1)		0.787	5.6 (±0.1)	
Is easily available in shops and Supermarkets.	0.632	5.6 (±0.1)		0.775	5.8 (±0.1)	
Explained variance			58.3%			72.1%
KMO			0.744			0.832
Cronbach's alpha			0.813			0.903

Factor analysis (KMO, explained variance and Cronbach´s alpha) was used to assure the unidimensionality of scale for the construct FCQ-Ecological Welfare (see Table 7). The model explained most of the variability of the response data around its mean for Norway (71.1%) and Portugal (88.1%). A high internal consistency coefficient for Norway (α= 0.901) and Portugal (α=0.966) was also verified. Sampling adequacy was above acceptance being 0.815 for Norway and 0.881 for Portugal. It was also assured that the FCQ-Ecological Welfare construct is unidimensional and consistent, with all five items presenting high loadings (>0.8), for both countries.

Table 7 - Factorial structure and consistency for the construct FCQ-Ecological Welfare, obtained for each of the countries under comparison

	Norway (n = 363)			**Portugal** (n = 303)		
	Loadings	**Mean (±Std.error)**	**Value**	**Loadings**	**Mean (±Std.error)**	**Value**
FCQ-Ecological Welfare		5.0 (±0.1)			5.2 (±0.1)	
Has been produced in a way that animals have not experienced pain.	0.828	5.3 (±0.1)		0.933	5.3 (±0.1)	
Has been produced in a way that animals' rights have been respected.	0.846	5.1 (±0.1)		0.940	5.4 (±0.1)	
Has been prepared in an environmentally friendly way.	0.872	4.8 (±0.1)		0.942	5.1 (±0.1)	
Has been produced in a way that has not shaken the balance of nature.	0.867	4.9 (±0.1)		0.953	5.1 (±0.1)	
Is packaged in an environmentally friendly way.	0.820	4.8 (±0.1)		0.925	5.2 (±0.1)	
Explained variance			71.7%			88.1%
KMO			0.815			0.881
Cronbach's alpha			0.901			0.966

The construct FNS 6 adapted was also verified in terms of consistency of scale (see Table 8). Sampling adequacy was above acceptance being 0.815 for Norway and 0.862 for Portugal. A high internal consistency coefficient for Norway (α= 0.815) and Portugal (α=0.891) was also verified. The model explained most of the variability of the response data around its mean for Norway (52.7%) and Portugal (65.5%). Data shows that the construct FNS6 adapted is unidimensional and consistent, with all six items presenting high loadings (>0.6), for both countries.

Table 8 - Factorial structure and consistency for the construct FNS6 adapted, obtained for each of the countries under comparison

	Norway (n = 363)			**Portugal** (n = 303)		
	Loadings	**Mean (±Std.error)**	**Value**	**Loadings**	**Mean (±Std.error)**	**Value**
FNS6 adapted		15.9 (±0.3)			19.1 (±0.5)	
I am constantly sampling new and different foods (R).	0.728	3.7 (±0.1)		0.786	3.6 (±0.1)	
I like foods from different cultures (R).	0.815	2.3 (±0.1)		0.875	2.9 (±0.1)	
Ethnic food looks too weird to eat.	0.722	2.0 (±0.1)		0.737	3.0 (±0.1)	
At social eating events (such as dinners or parties), I will try new foods (R).	0.642	2.5 (±0.1)		0.833	3.0 (±0.1)	
I am afraid to eat things I have never tried before.	0.673	2.3 (±0.1)		0.743	3.4 (±0.1)	
I like to try new ethnic restaurants (R).	0.762	3.2 (±0.1)		0.871	3.2 (±0.1)	
Explained variance			52.7%			65.5%
KMO			0.815			0.862
Cronbach's alpha			0.815			0.891

Lastly, the consistency of scale was tested for the construct Disgust (see Table 9). To verify the unidimensionality of scale for the construct FCQ-Health, factorial analysis was computed (KMO, explained variance and Cronbach´s alpha). The model explained most of the variability of the response data around its mean for Norway (74.7%) and Portugal (67.5%). Sampling adequacy was above acceptance being 0.824 for Norway and 0.848 for Portugal. A high internal consistency coefficient for Norway (α= 0.907) and Portugal (α=0.873) was also verified. Data shows that the Disgust construct is also unidimensional and consistent, with all five items presenting high loadings (>0.6), for both countries.

Table 9 - Factorial structure and consistency for the construct Disgust, obtained for each of the countries under comparison

	Norway (n = 363)			**Portugal** (n = 303)		
	Loadings	**Mean (±Std.error)**	**Value**	**Loadings**	**Mean (±Std.error)**	**Value**
Disgust		3.8 (±0.1)			3.5 (±0.1)	
The idea of insects makes me nauseous.	0.915	4.0 (±0.1)		0.914	3.3 (±0.1)	
The idea of insects makes me ill.	0.911	3.8 (±0.1)		0.899	2.9 (±0.1)	
Eating insects is disgusting.	0.926	3.6 (±0.1)		0.843	3.9 (±0.1)	
I am offended by the idea of eating insects.	0.921	3.5 (±0.1)		0.808	2.6 (±0.1)	
If an insect crawls on my favorite food I won't eat it.	0.604	3.9 (±0.1)		0.605	4.8 (±0.1)	
Explained variance			74.70%			67.50%
KMO			0.824			0.848
Cronbach's alpha			0.907			0.873

4.3 Acceptance of insects as food and feed

Regarding the perceived acceptance of different forms of entomophagy, through non-parametric tests (Mann-Whitney test), it was possible to conclude that there are significant differences in acceptance of the different forms of entomophagy among countries ($p< 0.05$) (see Table 10). Data also shows different homogenous groups in terms of acceptance of different forms of entomophagy. Norway had the highest average scores for all different forms of entomophagy, and sushi had the highest average acceptance scores for the Norwegian (5.3) and Portuguese (4.7) sample. In terms of perceived acceptance of different forms of entomphagy, for the Norwegian and Portuguese sample, average scores of acceptance were higher for fish (5.2 and 4.4 respectively), poultry (5.1, 4.4), pork (5.0, 4.3) and beef (5.0, 4.3) from animals fed with feed incorporating insects or insect protein. Protein bar with flour made out of cricket had a median score for the Portuguese (3.9) and Norwegian (3.5) sample. Edible insects had the lowest average acceptance scores among all forms of entomophagy for the Norwegian (3.2) and Portuguese (2.9) sample.

Table 10 - Mean (±SE) of acceptance values for each of the different forms of entomophagy and for suchi, for each of the countries under comparison.

	Norway (n=363)	Portugal (n=303)	
Acceptance	**Mean (±Std.error)**	**Mean (±Std.error)**	**p-value***
Edible insects	3.2 (±0.1) [c]	2.9 (±0.1) [c]	0.010
Protein bar with flour made out of cricket	3.9 (±0.1) [b]	3.5 (±0.1) [b]	0.006
Poultry from animals fed with feed incorporating insects or insect protein	5.1 (±0.1) [a]	4.4 (±0.1) [a]	0.000
Pork from animals fed with feed incorporating insects or insect protein	5.0 (±0.1) [a]	4.3 (±0.1) [a]	0.000
Beef from animals fed with feed incorporating insects or insect protein	5.0 (±0.1) [a]	4.3 (±0.1) [a]	0.000
Fish from animals fed with feed incorporating insects or insect protein	5.2 (±0.1) [a]	4.4 (±0.1) [a]	0.000
Sushi	5.3 (±0.1)	4.7 (±0.1)	0.000

a,b,c - Homogenous groups within each country according to the Wilcoxon test as 95% confidence level.
* - Comparisons between countries according to the Mann-Whitney test.

Cluster analysis was applied based on the degree of acceptance of the different forms of insects as food (direct and indirect) to identify different consumer segments. Four different groups of participants were identified based on their acceptance scores of different forms of entomphagy. These groups were divided into *Disgusted* (C1), *Rejecters* (C2), *Food acceptors* (C3) *and Acceptors* (C4) for each of the countries under comparison (see Table 11).

Table 11 - Acceptance levels for different forms of entomophagy as a function of the consumer segmentation within countries

	Norway (n=363)				Portugal (n=303)			
	C1-Disgusted	C2-Rejecters	C3-Feed acceptors	C4-Acceptors	C1 -Disgusted	C2-Rejecters	C3-Feed acceptors	C4-Acceptors
Acceptance	Mean (±SE)	Mean (±SE)	Mean (±SE)	Mean (±SE)	Mean (±SE)	Mean (±SE)	Mean (±SE)	Mean (±SE)
Edible insects	1.5 (±0.1)	3.5 (±0.1)	2.1 (±0.1)	4.7 (±0.1)	1.2 (±0.1)	2.5 (±0.1)	1.9 (±0.2)	5.1 (±0.1)
Protein bar with flour made out of cricket	1.9 (±0.1)	4.3 (±0.1)	2.4 (±0.2)	5.8 (±0.1)	1.6 (±0.1)	3.3 (±0.1)	2.4 (±0.2)	5.8 (±0.1)
Poultry from animals fed with feed incorporating insects or insect protein	2.2 (±0.1)	4.6 (±0.1)	6.2 (±0.1)	6.7 (±0.0)	1.8 (±0.1)	4.0 (±0.1)	6.0 (±0.1)	6.3 (±0.1)
Pork from animals fed with feed incorporating insects or insect protein	2.3 (±0.1)	4.3 (±0.1)	6.1 (±0.1)	6.7 (±0.0)	1.6 (±0.1)	3.8 (±0.1)	6.0 (±0.1)	6.3 (±0.1)
Beef from animals fed with feed incorporating insects or insect protein	2.3 (±0.1)	4.4 (±0.1)	6.0 (±0.1)	6.7 (±0.0)	1.7 (±0.1)	3.9 (±0.1)	6.0 (±0.1)	6.3 (±0.1)
Fish from animals fed with feed incorporating insects or insect protein	2.4 (±0.1)	4.7 (±0.1)	6.2 (±0.1)	6.7 (±0.0)	1.7 (±0.1)	3.9 (±0.1)	6.0 (±0.1)	6.3 (±0.1)

After the establishment of the different consumer segments within countries, a comparison between them and the socio demographics' characteristics, as well as the previously established constructs and acceptance of sushi was performed (see Table 12). Data shows that for the Norwegian sample, women comprised the majority of the groups *Disgusted*, *Rejecters*, *Feed acceptors* and *Acceptors*. The same applied for the Portuguese sample, except that in Portugal the group *Acceptors* had a slightly higher percentage of men (52.7%).

In the Norwegian sample, the majority of the participants from the group *Disgusted* were within the age group [18;35[(38.3%). Similarly, for the Portuguese sample the majority of participants from the group *Disgusted* were also within the age group [18;35[(36.8%) but equally also within the age group 55+ (36.8%). The majority of participants from the group *Rejecters* were concentrated within the age group [35;55[for the Norwegian sample (43.5%), and within the age group [18;35[for the Portuguese sample (43.2%). For the group *Feed Acceptors*, the majority of participants were equally concentrated within the age group [18;35[for the Norwegian sample (39.1%) and for the Portuguese sample (65.9%). In the group *Acceptors* there were more participants within the age group [35;55[for the Norwegian sample (45.2%) and within the age group [18;35[for the Portuguese sample (49.5%). The lowest average age for the Norwegian sample was 40.4 years and was within the group *Rejecters.* For the Portuguese sample, the lowest average age (35.5 years) was within the group *Feed acceptors*.

In the Norwegian sample, the majority of groups *Disgusted* (49.4%), *Rejecters* (70.7%), *Feed acceptors* (70.3%), and *Acceptors* (66.7%) was married. The same applied for the Portuguese sample where married participants were represented as: *Disgusted* (60.5%), *Rejecters* (55.8%), *Feed Acceptors* (46.3%), *Acceptors* (57.1%). In the Norwegian sample, the majority of the group *Disgusted* had a lower education (63.0%). Contrarily, the groups *Rejecters* (55.4%), *Feed acceptors* (60.9%) and *Acceptors* (69.8%) had a higher education. In the Portuguese sample, the majority of the group *Disgusted* (63.2%) and *Rejecters* (55.8%) had a lower education level; whereas the majority of the group *Feed acceptors* (61%) and *Acceptors* (54.9%) had a higher education level. In terms of economic situation of the samples, the highest mean scores were concentrated within the group *Acceptors* for the Norwegian being 5.1 and Portuguese sample 4.0.

For the constructs *FCQ-Health* and *FCQ-convenience* the highest mean was concentrated within the group *Rejecters* for the Norwegian sample being 5.0 and 5.0, and *Acceptors* for the Portuguese sample being 5.9 and 5.7, respectively. For the construct *FCQ-Ecological Welfare*, the highest mean scores was equally concentrated in the group Acceptors for the Norwegian (5.3) and Portuguese (5.3) sample. The highest mean for the constructs *FNS, FNS6 adapted and Disgust* is, for both samples, within the group *Acceptors*, being respectively (32.7, 18.4, 5.1) for the Norwegian sample and (43.3, 25.1, 4.7) for the Portuguese sample.

When comparing the four groups previously established and the acceptance of sushi, the group with the highest mean is within *Acceptors* for the Norwegian (6.2) and for the Portuguese (6.2) sample. Moreover, in both samples, the majority of participants of all groups had a high *Familiarity* with insects. Still, in both samples, the majority of all groups had no *Exposure* to edible insects.

Table 12 - Comparison among cluster groups identified and social demographic characteristics and constructs and sushi

	Norway (n=363)				Portugal (n=303)			
	C1 - Disgusted	C2 - Rejecters	C3 - Feed acceptors	C4 - Acceptors	C1 - Disgusted	C2 - Rejecters	C3 - Feed acceptors	C4 - Acceptors
Gender								
Female	62 (76.5%)	64 (69.6%)	44 (68.8%)	75 (59.5%)	50 (65.8%)	62 (65.3%)	25 (61%)	43 (47.3%)
Male	19 (23.5%)	28 (30.4%)	20 (31.3%)	51 (40.5%)	26 (34.2%)	33 (34.7%)	16 (39%)	48 (52.7%)
Age group								
[18;35[	31 (38.3%)	34 (37%)	25 (39.1%)	46 (36.5%)	28 (36.8%)	41 (43.2%)	27 (65.9%)	45 (49.5%)
[35;55[	24 (29.6%)	40 (43.5%)	24 (37.5%)	57 (45.2%)	20 (26.3%)	33 (34.7%)	9 (22%)	27 (29.7%)
55+	26 (32.1%)	18 (19.6%)	15 (23.4%)	23 (18.3%)	28 (36.8%)	21 (22.1%)	5 (12.2%)	19 (20.9%)
Age								
Mean (±SE)	*42 (±1.9)*	*40.4 (±1.5)*	*41.9 (±1.8)*	*40.5 (±1.2)*	*44.6 (±1.8)*	*39.7 (±1.5)*	*35.5 (±2.1)*	*38.5 (±1.5)*
Marital status								
Single	28 (34,6%)	26 (28,3%)	17 (26,6%)	35 (27,8%)	20 (26,3%)	28 (29,5%)	19 (46,3%)	30 (33%)
Married	40 (49,4%)	65 (70,7%)	45 (70,3%)	84 (66,7%)	46 (60,5%)	53 (55,8%)	19 (46,3%)	52 (57,1%)
Separated	10 (12,3%)	1 (1,1%)	2 (3,1%)	7 (5,6%)	7 (9,2%)	10 (10,5%)	1 (2,4%)	9 (9,9%)
Widow	3 (3,7%)	0 (0%)	0 (0%)	0 (0%)	3 (3,9%)	4 (4,2%)	2 (4,9%)	0 (0%)
Higher Education								
No	51 (63%)	41 (44,6%)	25 (39,1%)	38 (30,2%)	48 (63,2%)	53 (55,8%)	16 (39%)	41 (45,1%)
Yes	30 (37%)	51 (55,4%)	39 (60,9)%	88 (69,8%)	28 (36,8%)	42 (44,2%)	25 (61%)	50 (54,9%)
Economic situation								
Mean (±SE)	*4.8 (±0.1)*	*4.8 (±0.1)*	*5 (±0.2)*	*5.1 (±0.1)*	*3.6 (±0.1)*	*3.7 (±0.1)*	*3.7 (±0.1)*	*4 (±0.1)*
FCQ-H								
Mean (±SE)	*4.9 (±0.1)*	*5 (±0.1)*	*4.7 (±0.1)*	*4.9 (±0.1)*	*5.8 (±0.1)*	*5.8 (±0.1)*	*5.5 (±0.2)*	*5.9 (±0.1)*
FCQ-C								
Mean (±SE)	*4.9 (±0.1)*	*5 (±0.1)*	*4.9 (±0.1)*	*4.9 (±0.1)*	*5.5 ±(0.1)*	*5.5 (±0.1)*	*5 (±0.2)*	*5.7 (±0.1)*
FCQ-EW								
Mean (±SE)	*4.9 (±0.2)*	*5 (±0.1)*	*4.7 (±0.2)*	*5.3 (±0.1)*	*5.2 (±0.2)*	*5.2 (±0.2)*	*5.2 (±0.3)*	*5.3 (±0.2)*
FNS								
Mean (±SE)	*32.7 (±0.9)*	*29.2 (±0.7)*	*29 (±1.1)*	*25.1 (±0.6)*	*43.3 (±1.4)*	*34.1 (±1.3)*	*36.6 (±2)*	*23.7 (±0.9)*
FNS6 adapted								
Mean (±SE)	*18.4 (±0.7)*	*16.2 (±0.6)*	*16.7 (±0.7)*	*13.7 (±0.5)*	*25.1 (±1)*	*19.4 (±0.9)*	*20.8 (±1.3)*	*12.9 (±0.6)*
DISGUST								
Mean (±SE)	*5.1 (±0.2)*	*3.6 (±0.2)*	*4.3 (±0.2)*	*2.7 (±0.1)*	*4.7 (±0.2)*	*3.7 (±0.2)*	*3.9 (±0.2)*	*2.1 (±0.1)*
Sushi								
Mean (±SE)	*3.9 (±0.3)*	*5.3 (±0.2)*	*5.5 (±0.3)*	*6.2 (±0.1)*	*3.1 (±0.3)*	*4.6 (±0.2)*	*4.5 (±0.4)*	*6.2 (±0.2)*
Familiarity								
Low	20 (24.7%)	20 (21.7%)	8 (12.5%)	19 (15.1%)	14 (18.4%)	7 (7.4%)	5 (12.2%)	1 (1.1%)
High	61 (75.3%)	72 (78.3%)	56 (87.5%)	107 (84.9%)	62 (81.6%)	88 (92.6%)	36 (87.8%)	90 (98.9%)
Exposure								
No	72 (88.9%)	68 (73.9%)	51 (79.7%)	91 (72.2%)	76 (100%)	93 (97.9%)	40 (97.6%)	81 (89%)
Yes	9 (11.1%)	24 (26.1%)	13 (20.3%)	35 (27.8%)	0 (0%)	2 (2.1%)	1 (2.4%)	10 (11%)

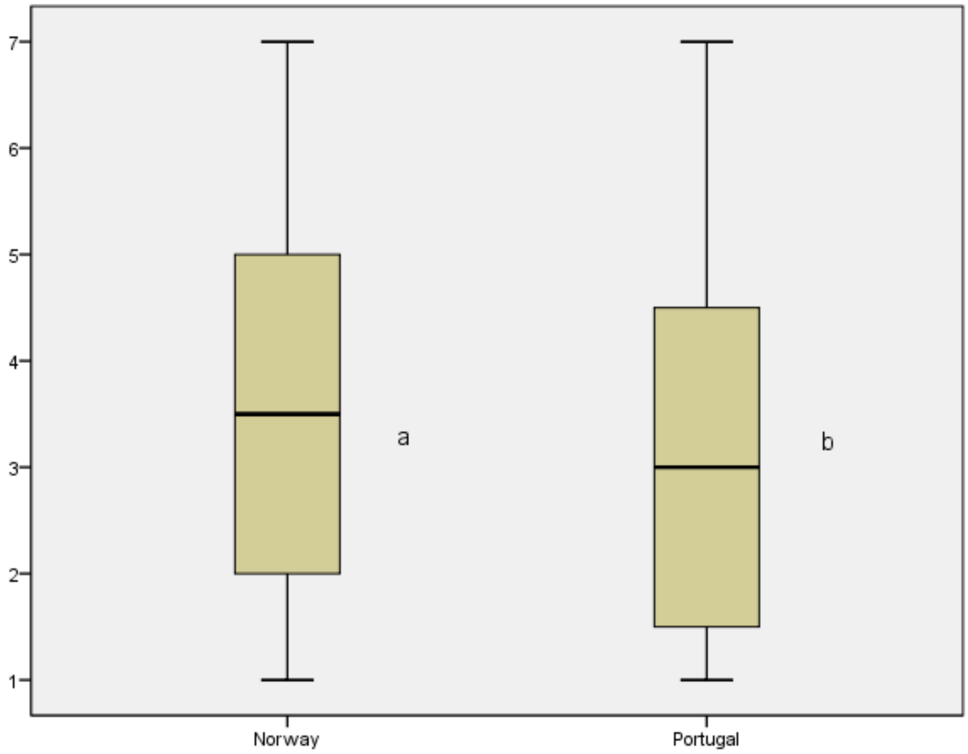
4.4 Determinants of acceptance

Through factorial analysis, a reduction of the different variables of acceptance of insects as food and feed was computed (table 13). Data shows that, for both countries, sampling adequacy was above acceptance being 0.864 for Norway and 0.890 for Portugal. For the acceptance of insects as food, a high internal consistency coefficient for Norway (α= 0.783) and Portugal (α=0.844) was verified. The same was confirmed for the acceptance of insects as feed for Norway (α=0.967) and Portugal (α=0.990). For the acceptance of insects as food, the model explains 31.0% of its variability for Norway and 33.9% for Portugal. For the acceptance of insects as feed, the model explained most of the variability of the response data around its mean for Norway (57.1%) and Portugal (59.5%). Data also shows that the acceptance of insects as food and feed presented high loadings for both countries (>0.783).

Table 13 - Reduction of different variables of acceptance of insetcs as food and feed for Portugal and Norway

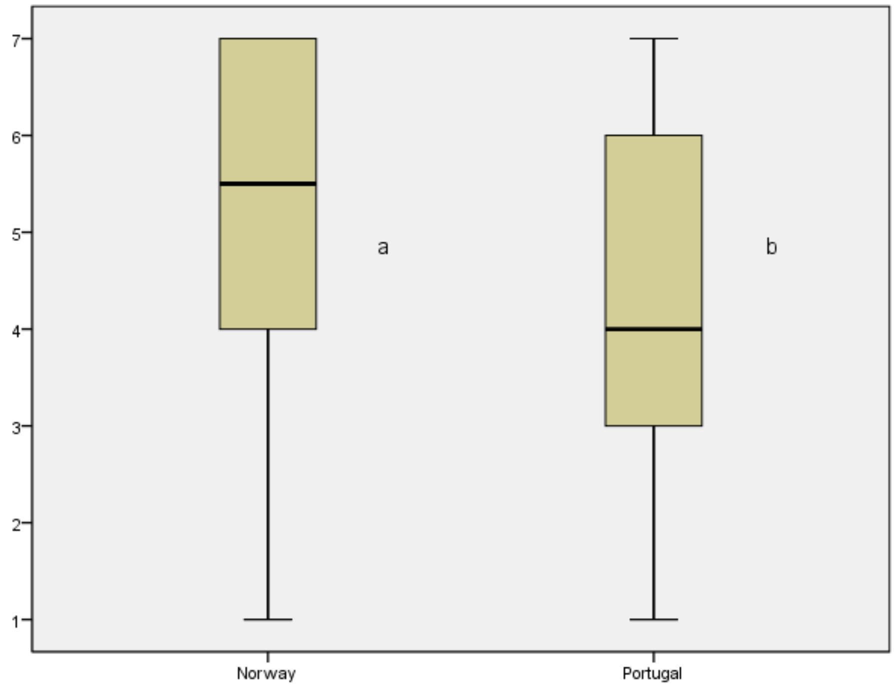
	Norway (n=363)	**Portugal (n=303)**
Acceptance of insects as food	**Loadings**	
Edible insects	0.878	0.861
Protein bar with flour made out of cricket	0.836	0.862
Explained Variance	31.01 %	33.97 %
Cronbach’s-α	0.783	0.844
Acceptance of insects as feed		
Poultry from animals fed with feed incorporating insects or insect protein	0.897	0.915
Pork from animals fed with feed incorporating insects or insect protein	0.918	0.907
Beef from animals fed with feed incorporating insects or insect protein	0.906	0.915
Fish from animals fed with feed incorporating insects or insect protein	0.881	0.910
Explained Variance	57.11 %	59.56 %
Cronbach’s alpha	0.967	0.990
KMO	0.864	0.890

According to the Mann-Whitney test, data shows that the overall acceptance of insects as food and feed is significantly different for Norway and Portugal, as can be seen in figures 2 and 3.



a,b - homogeneous groups according to the Mann-Whitney Test ($p<0.05$)

Figure 2 - Overall acceptance of insects as food for each country (mean)



a,b - homogeneous groups according to the Mann-Whitney Test ($p<0.05$)

Figure 3 - Overall acceptance of insects as feed for each country (mean)

In sequence, acceptance of insects as food and feed was transformed into a binary choice being 0= non-acceptance (factor scores between one and four) and 1 = acceptance (factor scores above four). Data shows that the overall acceptance mean of all forms of entomophagy is higher for Norway. Also, the overall acceptance mean of insects as feed is higher than of insects as food (Figure 4).

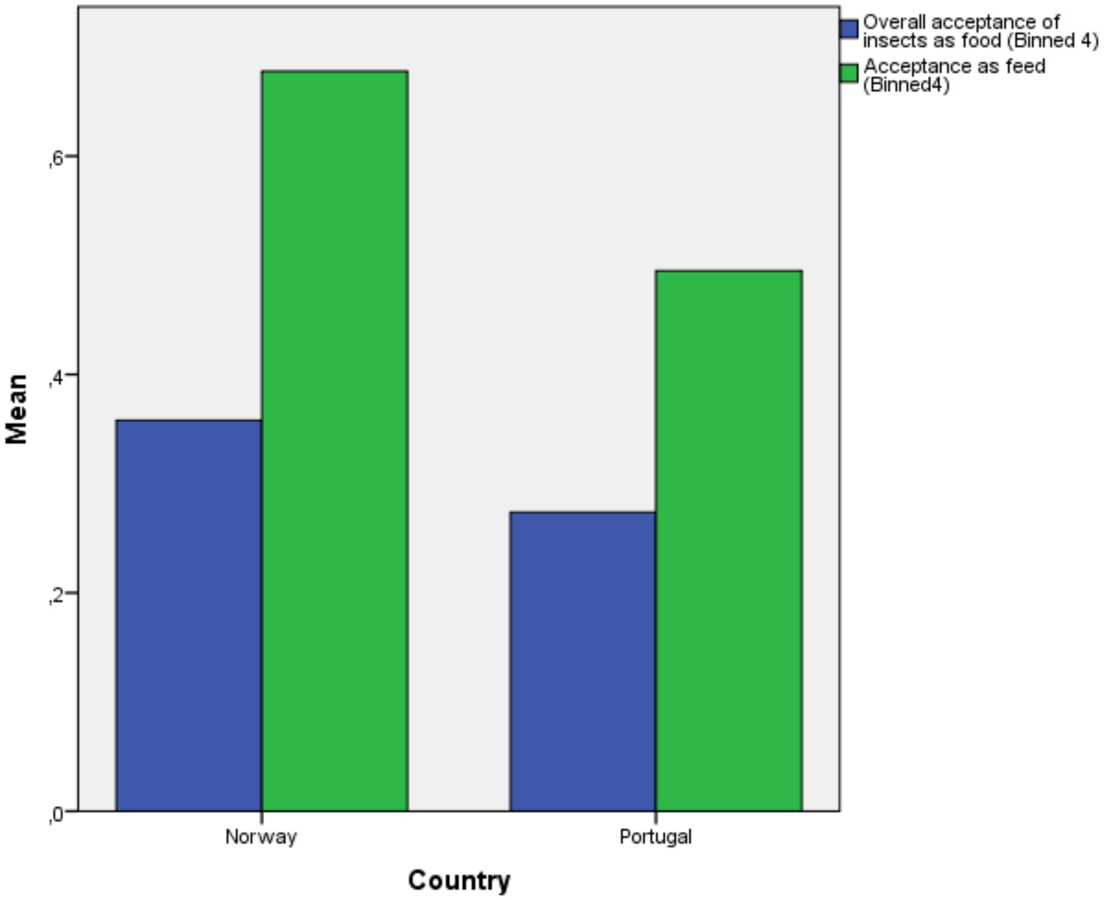


Figure 4 - Overall acceptance of insects as food and feed for each country

To ascertain the effects of the FCQ-Health, FCQ-Convenience, FCQ-Ecological Welfare, disgust, FNS, familiarity, exposure, and acceptance of sushi on the likelihood of acceptance of insects, binary logistic regressions were performed for each of the countries. In the first regression model, acceptance of insects as food was the dependent variable. In the second regression model, acceptance of insects as feed was the dependent variable. Socio-demographic variables, such as gender, age, and education, were also considered in both regression models. The regression model with acceptance of insects as food is significant for Norway (G^2 (11) = 168.840; $p \leq 0.001$) and for Portugal (G^2 (11) = 251.346; $p \leq 0.001$) and explains 50% of the Norwegian model and 75% of the Portuguese model, according to the Nagelkerke R square (R^2_N) (see Table 14). The regression model with acceptance of insects as feed is also significant and explains 44% of the Norwegian model and 39% of the Portuguese model (R^2_N) (See Table 15).

Data shows that for Norway, the acceptance of insects as food decreases significantly with the disgust (β= –0.760), and increases significantly with sushi acceptance (β= 0.218) and higher education (β= 0.621). For Portugal, the acceptance of insects as food decreases significantly with the disgust (β= –1.133) and FNS (β= – 0.082) and increases significantly with sushi acceptance (β= 0.539) (Table 14).

Table 14 - Coefficient estimates from binary logistic regression of acceptance of insects as food for Norway and Portugal

	Norway (n=363 / R^2=0.496*)			Portugal (n=303 / R^2=0.752*)		
	β	**Sig.**	**Exp(β)**	**β**	**Sig.**	**Exp(β)**
FCQ-Health	0.088	0.612	1.092	0.021	0.931	1.021
FCQ-Convenience	0.238	0.103	1.269	0.143	0.414	1.154
FCQ-Eco.Welfare	0.153	0.212	1.166	-0.046	0.777	0.955
Disgust	**-0.760**	**0.000**	**0.467**	**-1.133**	**0.000**	**0.322**
FNS	-0.035	0.060	0.965	**-0.082**	**0.001**	**0.921**
Sushi	**0.218**	**0.002**	**1.244**	**0.539**	**0.000**	**1.715**
Gender male	0.494	0.086	1.640	0.782	0.067	2.186
Familiarity	-0.450	0.211	0.638	2.084	0.111	8.033
Exposure	0.582	0.061	1.790	0.853	0.298	2.346
Higher Education	**0.621**	**0.031**	**1.861**	-0.516	0.214	0.597
Age	-0.009	0.375	0.991	0.010	0.524	1.010

*Nagelkerke R^2

Additionally, data shows that for Norway, the acceptance of insects as feed decreases significantly with the disgust (β= –0.361), and increases significantly with FCQ-convenience (β= 0.345), sushi acceptance (β= 0.291), familiarity (β= 0.668) and higher education (β= 1.016). For Portugal, the acceptance of insects as feed decreases significantly with the disgust (β= –0.381) and increases significantly with sushi acceptance (β= 0.331) and gender (β=0.693) (Table 15).

Table 15 - Coefficient estimates from binary logistic regression of acceptance of insects as feed for Norway and Portugal

	Norway (n=363 / R^2=0.442*)			**Portugal (n=303 / R^2=0.394*)**		
	β	**Sig.**	**Exp(β)**	**β**	**Sig.**	**Exp(β)**
FCQ-Health	-0.186	0.283	0.830	0.128	0.428	1.136
FCQ-Convenience	**0.345**	**0.010**	**1.411**	-0.092	0.455	0.912
FCQ-Eco. Welfare	-0.020	0.863	0.980	0.131	0.250	1.140
Disgust	**-0.361**	**0.000**	**0.697**	**-0.381**	**0.000**	**0.683**
FNS	-0.015	0.352	0.985	-0.017	0.186	0.983
Sushi	**0.291**	**0.000**	**1.338**	**0.331**	**0.000**	**1.392**
Gender male	0.145	0.631	1.156	**0.693**	**0.023**	**2.000**
Familiarity	**0.668**	**0.036**	**1.951**	0.564	0.336	1.757
Exposure	0.349	0.312	1.418	0.381	0.610	1.463
Higher Education	**1.016**	**0.000**	**2.762**	0.178	0.548	1.195
Age	0.008	0.371	1.008	-0.018	0.078	0.982

*Nagelkerke R^2

5 Discussion

The present study has investigated the determinants of consumers ‘acceptance of insects as food and feed. To assess these determinants, a set of scales was used: *FCQ-Health, FCQ-Convenience, FCQ-Ecological Welfare, FNS and Disgust.* All these instruments were validated through factor analysis; its reliability, unidimensionality, and internal consistency were high, as reported in previous research (Eertmans, Victoir et al. 2006, Januszewska, Pieniak et al. 2011, Copola, Verneau et al. 2014, Pauperio, Severo et al. 2014, Rozin 2014, Markovina, Stewart-Knox et al. 2015, Verbeke 2015).

Additionally, in line with Verbeke (2015), the overall acceptance of insects as food and as feed, for each country, was also confirmed through factor analysis. The internal consistency coefficients were high, as well as reliability indicators and loadings (Verbeke 2015).

Results for the acceptance of different forms of entomophagy revealed that, for the Norwegian sample, the acceptance of all the different forms of entomophagy was higher than on the Portuguese sample. Research has shown that some countries in the North of Europe such as Belgium (Megido, Sablon et al. 2014) and the Netherlands (Lensvelt and Steenbekkers 2014) have shown a relatively high acceptance for edible insects. One possible explanation for this is the fact that Belgium has recently become the first EU country to officially approve the sale of 10 species of insect at the end of 2013. Also, insects are now being stocked in main supermarkets in Netherlands, due to liberalized laws (Halloran, Vantomme et al. 2015). This suggests that the entrance of edible insects in the European market is happening in a faster pace in the North of Europe, which can be a positive influence on its population acceptance.

Sill, for both samples, the acceptance of pork, beef, poultry, and fish from animals fed with feed incorporating insects was the higher than for edible insects. Similar results have been found by Cunha *et al.* (2014) when investigating associations with insects in the context of food consumption. Cunha *et al.* (2014) showed that there was a significant preference for pork, poultry, beef and fish from animals fed with feed incorporating insects, over edible insects (Cunha, Moura et al. 2014). These results suggest that, in general, participants prefer indirect forms of entomophagy to direct forms.

Furthermore, our findings indicate that there was a higher acceptance of fish from animal fed with feed incorporating insects or insect protein in the Norwegian sample, and for poultry and fish from animal fed with feed incorporating insects or insect protein in the Portuguese sample. These results are in accordance with Verbeke *et al.* (2015), which stated that acceptance among participants towards the use of insects in animal feed were generally favorable, especially for fish and poultry (Verbeke, Spranghers et al. 2015). This higher acceptance of the use of insects in feed for fish and poultry may be explained by the fact that these species can have access to 'insects' in their 'natural' living environments (Henry, Gasco et al. 2015); insects are thus seen as a 'natural' or even 'naturally favored' feed source for fish and poultry. Access to 'natural' feed is in turn related to the possibility of engaging in natural (feeding) behavior and a more acceptable level of animal welfare (Vanhonacker, Van Loo et al. 2013). It is possible that this reasoning may have contributed to the favorable attitudes toward this acceptance of our participants.

Additionally, our results also show that participants accept edible insects in invisible form (protein bar with flour made out of crickets) rather than in visible form (edible insects). Support to this result is in the investigation conducted by Schosler *et al.* (2012) where fried mealworms, locusts and pizza with processed insects were offered as an option for adoption of meat substitutes. Participants demonstrated a low willingness to consume insects. But the pizza with processed insect protein was rated more positively among participants (Schosler, de Boer et al. 2012), suggesting that less visible forms of insects have higher acceptance.

In sequence to our results, four distinct consumer segments were established: *Disgusted, Rejecters, Feed acceptors,* and *Acceptors*. In the Norwegian sample, the group *Acceptors* accounted for the largest sum of participants, being 34.7% of the sample. Contrarily, for the Portuguese sample, the majority of participants were within the segment *Rejecters,* accounting for 31.3% of the sample. Similar results were recently found within the Portuguese population, where the same four segments were established and the majority of the sample was also concentrated in the group *Rejecters* (Cunha, Moura et al. 2014).

Still, the second largest segment for the Portuguese sample was *Acceptors*, being 30% of the sample. This result suggests that although these numbers are still relatively small, they are a signal of at least some degree of acceptance, which is consistent with Verbeke´s (2015) proposal that a small nucleus market for insects or insect protein that may further develop in Western countries (Verbeke 2015).

The segment *Feed acceptors* accounted for 18% of the Norwegian sample. Taking into consideration that the segment *Acceptors* (35%) also includes *Feed acceptors*, the acceptance of insects as feed accounted for 53% of the Norwegian sample. Similarly, the acceptance of insects as feed was 43.5% for of the Portuguese sample. Comparable results were found in a study that measured the attitudes and acceptance of Flanders (Belgium) citizens towards the use of insects in animal feed, where the idea of using insects in animal feed was accepted by close to half of the sample (Verbeke, Spranghers et al. 2015). These findings align with the insights from the baseline PROteINSECT survey (October 2013–March 2014), which showed that a similar proportion of a sample of 1302 participants accepted larvae of flies as a suitable source of protein for use in animal feed (Smith 2014).

For the Norwegian sample, the majority of the segment *Acceptors* and *Feed acceptors* was comprised of women, which can probably be explained by gender distribution of our sample. Still, for the Portuguese sample, even though the majority of the sample was comprised of women, men were the majority of the segment *Acceptors*. As shown in the literature, women tend to give a slightly lower rating to visible insects as a possible meat substitute considering it a form of non-acceptance (Schösler *et al.*, 2012). Furthermore, Verkebe (2015) also concluded that readiness to adopt insects was stronger among males than females (Schosler, de Boer et al. 2012, Verbeke 2015)

Additionally, for the Portuguese sample, our cluster results show that men are more likely to accept insects as fed than woman. This result is in line with Verbeke (2015) that suggests that attitudes towards the use of insects in feed and food in general were significantly more favorable among males than females (Verbeke 2015).

A Possible explanation for this gender difference in the Portuguese sample may be that males have a more adventurous taste orientation or find the idea of consuming insects less disgusting than women. In fact, a recent study found that a more adventurous taste orientation is associated with a higher interest in consuming insects (de Boer 2013). Rozin´s research (2014) also concluded that substantial predictors of acceptance of edible insects include gender and women display less acceptance of edible insects

(Rozin 2014).

For both samples, our results from logistic regression show that acceptance of insects as food and feed decreases significantly with disgust. Moreover, disgust was found to be more common among woman. In accordance with our results, Rozin (2014) also reported in his findings that substantial predictors of acceptance of edible insects include gender, concluding that there are fewer acceptances of edible insects in females. In his research, when females were asked an open-ended question about why they reject insects as food, the majority of them indicated “disgust” (Rozin 2014).

The majority of *Acceptors* in the Norwegian sample was from the age groups [35;55[and [18;35[. For the Portuguese sample the majority of *Acceptors* were within the age group [18;35[.Similar results were found by Scholser *et al*. (2012) who concluded that the positive score of the fictive pizza with processed insect protein, especially with younger people, demonstrates the potential advantages of alternative protein sources (Schosler, de Boer et al. 2012). This higher acceptance among younger participants could be explained by the fact that younger people are more audacious and open to new experiences (Lensvelt and Steenbekkers 2014).

The majority of *Accepters* and *Feed accepters*, in both samples, had a higher education level. Likewise, in both samples, our results from logistic regression show that participants with higher education are more likely to accept insects as food. Still, recent research on meat substitutes found that educational level does not have any influence on people’s willingness to adopt insects as a meat substitute (Verbeke 2015). However, Schosler *et al.* (2012) also have similar findings when it comes to education (Schosler, de Boer et al. 2012). Nevertheless, Hoek *et al.* (2004) found users of meat substitutes to have higher education levels, which is in accordance with our results, considering that edible insects are considered as an alternative protein source (Megido, Sablon et al. 2014).

Our logistic model shows that participants from the Norwegian sample that have high familiarity towards edible insects are more likely to accept insects as feed. Participants from all segments, in both samples, reported to have a high familiarity with edible insects. These results are in accordance with Verbeke (2015) who reported that the majority participants indicated having heard about the eating of insects and knew what it meant. This group was referred to as people who are familiar with the idea of eating insects (Verbeke 2015). Still in our results, for both samples, the segment *Acceptors* reported the highest scores of high familiarity, among the other segments, with edible insects. This is a positive sign since it suggests the importance of familiarity as a driver for food product acceptance. Support to this suggestion is in the research from Hoek *et al.* (2011) on plant-based meat-substitutes, which found that familiarity is a driver for usage of alternative protein sources (Hoek, Luning et al. 2011).

For both samples, the highest average scores for the food neophobia were among the segment *Disgusted* being this segment the most neophobic, and the lowest average scores were among the segment *Acceptors* being this segment the most neopholic. Moreover, for Portugal, our logistic regression results show that acceptance of insects as food decreases significantly with food neophobia. This result suggests that the more neophobic the participant is, the less they accept edible insects as food and feed. Likewise, Verbeke (2015) found food neophobia to be the most important factor that determines consumers' readiness to adopt insects as a meat substitute (Verbeke 2015). Megido *et al.* (2014) also emphasized the hypothesis about the effect of neophobia on consumers' willingness to eat insects (Megido, Sablon et al. 2014). A similar conclusion has also been reported by Hoek *et al.* (2011), when investigating acceptance of meat substitutes (Hoek, Luning et al. 2011). Our results are also consistent with Siegrist *et al.* (2013), who reported food neophobia to be a major barrier to the acceptance of and readiness to try novel foods (Siegrist, Hartmann et al. 2013), which is undeniably the position of insects in Western countries.

The majority of participants from both samples demonstrated having no previous experience with edible insects, which may explain the relatively low overall acceptance of edible insects. Still, the segment *Acceptors* comprised a considerable amount of participants who claimed having previous experience with edible insects. This is not surprising since trying an edible insect is, at some degree, a form of acceptance.

Participants from all segments, in both samples, demonstrated a high importance to the food choice motives health, convenience and ecological welfare. The ecological welfare food choice motive was considered to be the most important for the Norwegian sample. Our findings confirm that participants acknowledge the environmental benefits of the eating of insects. Moreover, for the Norwegian sample, our results from logistic regression show that acceptance of insects as feed is likely to increase with convenience. In accordance with our results, Verbeke (2015) also found that attentiveness to the environmental impact of food choice was also related to a higher likelihood of adopting insects as a meat substitute, being adopting insects as a meat substitute a form of acceptance. Likewise, his participants also see the importance of health when making food choices. In contrast with our findings, Verbeke (2015) states that health interest in food choice had a marginal effect on people's reactions to the eating of insects suggesting that people are not yet convinced about the possible health benefits of the consumption of edible insects as compared to meat (Verbeke 2015).

Our participants also demonstrated to add importance to convenience as a food choice motive. For instance, the perceived effect of convenience orientation among participants can suggest that insects might be more appealing as a snack or an ingredient in convenience foods, which can be supported by the findings presented by Schosler *et al.* (2012). This idea is also consistent with the recent positioning of insect-based foods such as termite-based crackers, Crikizz (a snack based on meal cassava and worms) and Buqadilla (a snack made from mealworms and chickpeas) (Schosler, de Boer et al. 2012, van Huis 2013).

The average scores for acceptance of sushi, in both samples, are clearly higher than for all the other forms of entomophagy. Still there is not a considerable difference between the acceptance of sushi and the acceptance of poultry, pork, beef and fish from animals fed with feed incorporating insects or insect protein. Our results from logistic regression further show that participants who accept sushi are more likely to accept insects as food and as feed. Moreover, sushi had the highest average scores among the segment *Accepters,* in which participants also have high familiarity with edible insects. Research states that familiarity seems to play an important role in novel food acceptance (Martins and Pliner 2005, Barrena, Garcia et al. 2015). Support to this is from Van Huis *et al.* (2013) who stated that the primary repulse towards a specific food can be changed into a preference, it depends on the personal familiarization and acceptance of something new, and such is the case of sushi (van Huis 2013). As such, familiarization with edible insects can be a way of bringing edible insects into a preference among Western countries.

Limitations

Our study was designed for different Western-European countries. As such, the development of the questionnaire should have taken into consideration wider cultural and socio-demographic differences. In addition, our sample also comprised significantly more women than men and this gender disproportion might have affected the results. Future consumer studies should explore additional sociocultural factors, such as religion, ethnicity and acculturation.

Another limitation of this research concerns to the fact that both samples were based on a non-random convenience sample. Therefore, findings from this study should be primarily considered as exploratory.

Lastly, the results of this study should not be instantly generalized for Portuguese and Norwegian populations or to other regions or parts of Western society, where the eating of insects is uncommon. Nevertheless, our insights are useful can be transferable to other study regions and populations. Further studies regarding the acceptance of insects as food and feed in other Western countries are therefore recommended.

Despite a few limitations (such as a non-random convenience sample and its consequences for data analysis and generalizability), this study contributes to the research on the determinants of acceptance on edible insects as food and feed, based on a cross-cultural study. It also contributes insights to inform public policy and industry developments.

6 Conclusion

This investigation offers consumer insights about the determinants of acceptance of edible insects in Western countries. Undoubtedly, positive outcomes in terms of the acceptance of insects as a food and feed in Western societies may contribute to safeguarding food and nutrition security. The results of this study can assist with 1) insect based product development, 2) market positioning of edible insects and insect based products, 3) communication of strategies in Western societies and also in societies where the acceptance of edible insects is higher.

Our findings show that there are differences between the acceptance of direct and indirect forms of entomophagy. Moreover, the relatively low acceptance of edible insects in their whole intact form (direct) indicates that strong manipulations that directly target mechanisms underlying disgust reactions and/or particular groups could be necessary in order to reduce individuals' beliefs about the disgusting properties of novel animal foods.

This study also reveals the main factors that increase or decrease the acceptance of insects as food and feed being: disgust towards edible insects, acceptance of sushi, higher education, convenience, gender, familiarization and food neophobia. For both samples, disgust was confirmed to decrease the likelihood of acceptance of insects as food and feed. Contrarily, for both samples, participants that accept sushi are more likely to accept insects as food and feed. Still, although Verbeke (2015) found more explanatory variables than we found in our study, the explained variation of our logistic regressions models is higher. These findings can be valuable for future studies on acceptance of insects as food and feed.

This study has also profiled the consumer groups in Western societies that have higher levels of acceptance towards edible insect. This group can be targeted as possible trendsetters. The profile of this group is younger males, who are interested in the environmental impact of their food choices, showing low levels of neophobia and disgust, and high familiarity with edible insects.

The strategy for getting people to be more familiar with edible insects and its benefits, and the consumer profile established by this research can be an excellent tool for companies, researchers and organizations willing to promote and/or trade edible insects as food source.

References

Aigbodion, F. I., I. N. Egbon and E. Erukakpomren (2012). "A preliminary study on the entomophagous response of Gallus gallus domesticus (Galliformes: Phasianidae) to adult Periplaneta americana (Blattaria: Blattidae)." International Journal of Tropical Insect Science **32**(3): 123-125.

Alves, H., L. M. Cunha, Z. Lopes, M. C. Santos, R. Costa-Lima and A. P. Moura (2005). Motives underlying food choice: a study of individual factors used by the portuguese population. 6th Pangborn Sensory Science Symposium. North Yorkshire, UK.

Appadurai, A. (1981). "Gastro-Politics in Hindu South-Asia." American Ethnologist **8**(3): 494-511.

Ares, G. and A. Gambaro (2007). "Influence of gender, age and motives underlying food choice on perceived healthiness and willingness to try functional foods." Appetite **49**(1): 148-158.

Ares, G., L. Saldamando, A. Gimenez, A. Claret, L. M. Cunha, L. Guerrero, A. P. Moura, D. C. R. Oliveira, R. Symoneaux and R. Deliza (2014). "Consumers' association with wellbeing in a food related context: A cross-cultural study."

Ballantine, J. (2000). "Man eating bugs: The art and science of eating insects." Teaching Sociology **28**(3): 261-261.

Banjo, A. D., O. A. Lawal and E. A. Songonuga (2006). "The nutritional value of fourteen species of edible insects in southwestern Nigeria." African Journal of Biotechnology **5**(3): 298-301.

Barre, A., S. Caze-Subra, C. Gironde, F. Bienvenu, J. Bienvenu and P. Rouge (2014). "Entomophagy and the risk of allergy." Revue Francaise D Allergologie **54**(4): 315-321.

Barrena, R., T. Garcia and M. Sanchez (2015). "Analysis of personal and cultural values as key determinants of novel food acceptance. Application to an ethnic product." Appetite **87**: 205-214.

Bass, W. M. (1991). "Human Biology and Behavior - an Anthropological Perspective, 5th Edition - Weiss,Ml, Mann,Ae." American Journal of Physical Anthropology **84**(1): 103-103.

Bastide, N. M., F. Chenni, M. Audebert, R. L. Santarelli, S. Tache, N. Naud, M. Baradat, I. Jouanin, R. Surya, D. A. Hobbs, G. G. Kuhnle, I. Raymond-Letron, F. Gueraud, D. E. Corpet and F. H. F. Pierre (2015). "A Central Role for Heme Iron in Colon Carcinogenesis Associated with Red Meat Intake." Cancer Research **75**(5): 870-879.

Becker, C., M. P. Alfonso-Durruty, N. Misarti and A. Troncoso (2014). "Isotopic analysis of diet among Archaic (10.000-2.000BP) and Early Ceramic (2000-1500BP) prehistoric groups in North-Central Chile." American Journal of Physical Anthropology **153**: 74-75.

Bednarova, M., M. Borkovcova and T. Komprda (2014). "Purine derivate content and amino acid profile in larval stages of three edible insects." J Sci Food Agric **94**(1): 71-76.

Belluco, S., C. Losasso, M. Maggioletti, C. C. Alonzi, M. G. Paoletti and A. Ricci (2013). "Edible Insects in a Food Safety and Nutritional Perspective: A Critical Review." Comprehensive Reviews in Food Science and Food Safety **12**(3): 296-313.

Bendiksen, E. A., C. A. Johnsen, H. J. Olsen and M. Jobling (2011). "Sustainable aquafeeds: Progress towards reduced reliance upon marine ingredients in diets for farmed Atlantic salmon (Salmo salar L.)." Aquaculture **314**(1-4): 132-139.

Berenbaum, M. (1995). "Phototoxicity of plant secondary metabolites: insect and mammalian perspectives." Arch Insect Biochem Physiol **29**(2): 119-134.

Berillo, D. and N. Volkova (2014). "Preparation and physicochemical characteristics of cryogel based on gelatin and oxidised dextran." Journal of Materials Science **49**(14): 4855-4868.

Berntssen, M. H. G., K. Julshamn and A. K. Lundebye (2010). "Chemical contaminants in aquafeeds and Atlantic salmon (Salmo salar) following the use of traditional- versus alternative feed ingredients." Chemosphere **78**(6): 637-646.

Berntssen, M. H. G., R. Ornsrud, K. Hamre and K. K. Lie (2015). "Polyaromatic hydrocarbons in aquafeeds, source, effects and potential implications for vitamin status of farmed fish species: a review." Aquaculture Nutrition **21**(3): 257-273.

Betsingerl, T. K. and M. O. Smith (2007). "Dental health, diet, and social variation in late prehistoric eastern tennessee." American Journal of Physical Anthropology: 74-74.

Boardman, L., J. G. Sorensen and J. S. Terblanche (2013). "Physiological responses to fluctuating thermal and hydration regimes in the chill susceptible insect, Thaumatotibia leucotreta." Journal of Insect Physiology **59**(8): 781-794.

Bodenheimer, F. S. (1951). Insects as human food. The Hague, Springer.

Bosch, G., S. Zhang, D. G. Oonincx and W. H. Hendriks (2014). "Protein quality of insects as potential ingredients for dog and cat foods." J Nutr Sci **3**: e29.

Boulanger, N., P. Bulet and C. Lowenberger (2006). "Antimicrobial peptides in the interactions between insects and flagellate parasites." Trends Parasitol **22**(6): 262-268.

Bowzer, J. and J. Trushenski (2015). "Growth Performance of Hybrid Striped Bass, Rainbow Trout, and Cobia Utilizing Asian Carp Meal-Based Aquafeeds." North American Journal of Aquaculture **77**(1): 59-67.

Branckaert, R. D. (1995). "Minilivestock - Sustainable Animal Resource for Food Security." Biodiversity and Conservation **4**(3): 336-338.

Bregnbak, D., U. F. Friis, C. Zachariae, T. Menne and J. D. Johansen (2014). "Protein contact dermatitis caused by worms and insects used to feed exotic birds." Contact Dermatitis **70**(1): 64-66.

Brislin, R. W. (1970). "Back-Translation for Cross-Cultural Research." Journal of Cross-Cultural Psychology **1**(3): 185-216.

Bryant, V. M. (1974). "Prehistoric Diet in Southwest Texas - Coprolite Evidence." American Antiquity **39**(3): 407-420.

Buentello, A., D. Jirsa, F. T. Barrows and M. Drawbridge (2015). "Minimizing fishmeal use in juvenile California yellowtail, Seriola lalandi, diets using non-GM soybeans selectively bred for aquafeeds." Aquaculture **435**: 403-411.

Cadete, S., L. M. Cunha and R. Lima (2010). "Characterization of a consumer panel based on food neophobia and variety seeking tendency."

Cadete, S., L. M. Cunha and R. Lima (2010). "Translation into Portuguese and exploratory application of the Food Neophobia Scale and of the Variety Seeking Tendency Scale."

Camarasa, J. G. and E. Serra-Baldrich (1993). "Contact urticaria from a worm (Nereis diversicolor)." Contact Dermatitis **28**(4): 248-249.

Chakravorty, J., S. Ghosh, C. Jung and V. B. Meyer-Rochow (2014). "Nutritional composition of Chondacris rosea and Brachytrupes orientalis: Two common insects used as food by tribes of Arunachal Pradesh, India." Journal of Asia-Pacific Entomology **17**(3): 407-415.

Chakravorty, J., S. Ghosh and V. B. Meyer-Rochow (2011). "Practices of entomophagy and entomotherapy by members of the Nyishi and Galo tribes, two ethnic groups of the state of Arunachal Pradesh (North-East India)." Journal of Ethnobiology and Ethnomedicine **7**.

Chakravorty, J., S. Ghosh and V. B. Meyer-Rochow (2011). "Practices of entomophagy and entomotherapy by members of the Nyishi and Galo tribes, two ethnic groups of the state of Arunachal Pradesh (North-East India)." J Ethnobiol Ethnomed **7**: 5.

Chakravorty, J., S. Ghosh and V. B. Meyer-Rochow (2013). "Comparative Survey of Entomophagy and Entomotherapeutic Practices in Six Tribes of Eastern Arunachal Pradesh (India)." Journal of Ethnobiology and Ethnomedicine **9**.

Cho, E. and S. Kim (2015). "Cronbach's Coefficient Alpha: Well Known but Poorly Understood." Organizational Research Methods **18**(2): 207-230.

Christensen, D. L., F. O. Orech, M. N. Mungai, T. Larsen, H. Friis and J. Aagaard-Hansen (2006). "Entomophagy among the Luo of Kenya: a potential mineral source?" International Journal of Food Sciences and Nutrition **57**(3-4): 198-203.

Cooke, L., J. Wardle and E. L. Gibson (2003). "Relationship between parental report of food neophobia and everyday food consumption in 2-6-year-old children." Appetite **41**(2): 205-206.

Copola, A., F. Verneau and F. Caraciolo (2014). "Neophobia in Food Consumption: An Empirical Application of the Ftns Scale in Southern Italy." Italian Journal of Food Science **26**(1): 81-90.

Costa-Neto, E. M., P. C. (2010). "Animal Species Traded as Ethnomedicinal Resources in the Federal District, Central West Region of Brazil."

Cunha, L., A. Moura, Z. Lopes and M. Silva (2010). "Public perceptions of food-related hazards: an application to Portuguese consumers." British Food Journal(112): 522.

Cunha, L. M., A. P. Moura and R. Costa-Lima (2014). "Consumers' associations with insects in the context of food consumption: comparisons from acceptors to disgusted."

Cunha, L. M., A. P. Moura, R. Costa-Lima and A. Frias (2007). "Valorisation of menu labelling at fast food restaurants: exploring consumer perceptions." Brazilian Journal of Food Technology.

Dalduf, W. V. (1938). "The rise of entomophagy among Lepidoptera." American Naturalist **72**: 358-379.

Dar, M. (2014). "Edible: An Adventure into the World of Eating Insects and the Last Great Hope To Save the Planet." Library Journal **139**(2): 93-93.

de Boer, J., H. Schosler and H. Aiking (2014). ""Meatless days" or "less but better"? Exploring strategies to adapt Western meat consumption to health and sustainability challenges." Appetite **76**: 120-128.

Defoliart, G. R. (1995). "Edible Insects as Minilivestock." Biodiversity and Conservation **4**(3): 306-321.

DeFoliart, G. R. (1999). "Insects as food: Why the Western attitude is important." Annual Review of Entomology **44**: 21-50.

Deroy, O. (2015). "Eat insects for fun, not to help the environment." Nature **521**(7553): 395.

Dodd, L. E., M. J. Lacki and L. K. Rieske (2011). "Habitat Associations of Lepidoptera in the Ozark Mountains of Arkansas." Journal of the Kansas Entomological Society **84**(4): 271-284.

Domnas, A. J. and S. A. Warner (1991). "Biochemical activities of entomophagous fungi." Crit Rev Microbiol **18**(1): 1-13.

Donatiello, J. E. (2015). "The World's Population: An Encyclopedia of Critical Issues, Crises, and Ever-Growing Countries." Reference & User Services Quarterly **54**(4): 85-86.

Doos, B. R. (2002). "Population growth and loss of arable land." Global Environmental Change-Human and Policy Dimensions **12**(4): 303-311.

Dufour, D. (1990). "Insects as Food - Aboriginal Entomophagy in the Great-Basin - Sutton,Mq." American Anthropologist **92**(1): 214-215.

Dzerefos, C. M. and E. T. F. Witkowski (2014). "The potential of entomophagy and the use of the stinkbug, Encosternum delegorguei Spinola (Hemipera: Tessaratomidae), in sub-Saharan Africa." African Entomology **22**(3): 461-472.

Dzerefos, C. M., E. T. F. Witkowski and R. Toms (2009). "Life-history traits of the edible stinkbug, Encosternum delegorguei (Hem., Tessaratomidae), a traditional food in southern Africa." Journal of Applied Entomology **133**(9-10): 749-759.

Eertmans, A., A. Victoir, G. Notelaers, G. Vansant and O. Van den Bergh (2006). "The Food Choice Questionnaire: Factorial invariant over western urban populations?" Food Quality and Preference **17**(5): 344-352.

Falciglia, G. A., S. C. Couch, L. S. Gribble, S. M. Pabst and R. Frank (2000). "Food neophobia in childhood affects dietary variety." Journal of the American Dietetic Association **100**(12): 1474-+.

Fallon, A. E., P. Rozin and P. Pliner (1984). "The Childs Conception of Food - the Development of Food Rejections with Special Reference to Disgust and Contamination Sensitivity." Child Development **55**(2): 566-575.

FEFAC. (2012). "Statistics 2012. Eurpean Feed Manufactures´Federation." Retrieved 07/10/2015, 2015.

Feldt, L. S. (1980). "A Test of the Hypothesis That Cronbach Alpha-Reliability Coefficient Is the Same for 2 Tests Administered to the Same Sample." Psychometrika **45**(1): 99-105.

Feng, C. H. I. (2012). "The Tale of Sushi: History and Regulations." Comprehensive Reviews in Food Science and Food Safety **11**(2): 205-220.

Fernandez-Ruiz, V., A. Claret and C. Chaya (2013). "Testing a Spanish-version of the Food Neophobia Scale." Food Quality and Preference **28**(1): 222-225.

Fotopoulos, C., A. Krystallis, M. Vassallo and A. Pagiaslis (2009). "Food Choice Questionnaire (FCQ) revisited. Suggestions for the development of an enhanced general food motivation model." Appetite **52**(1): 199-208.

Gahukar, R. T. (2012). "Entomophagy can support rural livelihood in India." Current Science **103**(1): 10-10.

Ganga, R., S. M. Tibbetts, C. L. Wall, D. A. Plouffe, M. D. Bryenton, A. R. Peters, C. D. Runighan, J. T. Buchanan and S. P. Lall (2015). "Influence of feeding a high plant protein diet on growth and nutrient utilization to combined 'all-fish' growth-hormone transgenic diploid and triploid Atlantic salmon (Salmo salar L.)." Aquaculture **446**: 272-282.

Gardiner, A. J. and E. M. Gardiner (2003). "Edible insects, Part 1. Preparation of species from Mushumbi Pools, Zimbabwe." African Entomology **11**(1): 125-127.

Garrouste, R. (2009). "First observation in natura of entomophagy of Panstrongylus geniculatus (Latreille 1811), vector of Chagas disease (Hemiptera: Reduviidae)." Annales De La Societe Entomologique De France **45**(3): 302-304.

Gatlin, D. M., F. T. Barrows, P. Brown, K. Dabrowski, T. G. Gaylord, R. W. Hardy, E. Herman, G. S. Hu, A. Krogdahl, R. Nelson, K. Overturf, M. Rust, W. Sealey, D. Skonberg, E. J. Souza, D. Stone, R. Wilson and E. Wurtele (2007). "Expanding the utilization of sustainable plant products in aquafeeds: a review." Aquaculture Research **38**(6): 551-579.

Gilbert, S. (1984). "Figuring out Food Preferences - Japanese Savor Sushi - Americans Favor Franks - Why." Science Digest **92**(10): 12-12.

Goetz, A. R., J. R. Cougle and H. J. Lee (2013). "Revisiting the factor structure of the 12-item Disgust Propensity and Sensitivity Scale - Revised: Evidence for a third component." Personality and Individual Differences **55**(5): 579-584.

Gorham, J. R. (1979). "The significance for human health of insects in food." Annu Rev Entomol **24**: 209-224.

Greenwald, A. G., D. E. McGhee and J. L. K. Schwartz (1998). "Measuring individual differences in implicit cognition: The implicit association test." Journal of Personality and Social Psychology **74**(6): 1464-1480.

Guo, J. Y., W. Wei and L. X. Zhan (2015). "Red and processed meat intake and risk of breast cancer: a meta-analysis of prospective studies." Breast Cancer Research and Treatment **151**(1): 191-198.

Haidt, J., C. Mccauley and P. Rozin (1994). "Individual-Differences in Sensitivity to Disgust - a Scale Sampling 7 Domains of Disgust Elicitors." Personality and Individual Differences **16**(5): 701-713.

Haidt, J., P. Rozin and C. Mccauley (1992). "What Is Disgusting - 7 Kinds of Things." International Journal of Psychology **27**(3-4): 192-192.

Hair, J., R. Anderson, R. Tatham and W. Black (1998). Multivariate Data Analysis. Englewood cliffs, NJ., Prentice Hall.

Halloran, A., P. Vantomme, Y. Hanboonsong and S. Ekesi (2015). "Regulating edible insects: the challenge of addressing food security, nature conservation, and the erosion of traditional food culture." Food Security **7**(3): 739-746.

Hardouin, J. (1997). "Developing minilivestock as source of human food, animal feed or revenue: A brief overview." Ecology of Food and Nutrition **36**(2-4): 95-&.

Harris, F. M. and S. Mohammed (2003). "Relying on nature: wild foods in northern Nigeria." Ambio **32**(1): 24-29.

Harris, F. M. A. and S. Mohammed (2003). "Relying on nature: Wild foods in Northern Nigeria." Ambio **32**(1): 24-29.

Hasegawa, T., N. Sakai and S. Imada (2008). "Psychological factors affecting Japanese university students' food selection for lunch of either convenience store or department store riceballs." International Journal of Psychology **43**(3-4): 633-633.

Hawkes, N. (2014). "Cutting Europe's meat and dairy consumption would benefit health and environment, says report." Bmj-British Medical Journal **348**.

Henry, M., L. Gasco, G. Piccolo and E. Fountoulaki (2015). "Review on the use of insects in the diet of farmed fish: Past and future." Animal Feed Science and Technology **203**: 1-22.

Hoek, A. C., P. A. Luning, P. Weijzen, W. Engels, F. J. Kok and C. de Graaf (2011). "Replacement of meat by meat substitutes. A survey on person- and product-related factors in consumer acceptance." Appetite **56**(3): 662-673.

Honkanen, P. and L. Frewer (2009). "Russian consumers' motives for food choice." Appetite **52**(2): 363-371.

Hoover, K. C. and F. L. Williams (2015). "Variation in regional diet and mandibular morphology in prehistoric Japanese hunter-gatherer-fishers." American Journal of Physical Anthropology **156**: 169-169.

Illgner, P. and E. Nel (2000). "The geography of edible insects in sub-Saharan Africa: A study of the mopane caterpillar." Geographical Journal **166**: 336-351.

Ivy, T. M., J. C. Johnson and S. K. Sakaluk (1999). "Hydration benefits to courtship feeding in crickets." Proceedings of the Royal Society B-Biological Sciences **266**(1428): 1523-1527.

Januszewska, R., Z. Pieniak and W. Verbeke (2011). "Food choice questionnaire revisited in four countries. Does it still measure the same?" Appetite **57**(1): 94-98.

Januszewska, R., Z. Pieniak and W. Verbeke (2011). "Food choice questionnaire revisited in four countries. Does it still measure the same?" Appetite **57**(1): 94-98.

Jeong, J., Y. Oh, M. Chun and J. D. Kralik (2014). "Preference-Based Serial Decision Dynamics: Your First Sushi Reveals Your Eating Order at the Sushi Table." Plos One **9**(5).

Johnson, D. V., Ed. (2010). The contribution of edible forest insects to human nutrition and to forest management: current status and future potential. Forest insects as food: humans bite back.

Kaiser, H. F. (1981). "A Revised Measure of Sampling Adequacy for Factor-Analytic Data Matrices." Educational and Psychological Measurement **41**(2): 379-381.

Kaliba, A. R., C. R. Engle and D. Bouras (2010). "Economic Analysis of Producing Fishmeal and Fish Oil from Channel Catfish, Ictalurus punctatus, Processing Wastes." Journal of the World Aquaculture Society **41**(1): 49-60.

Kang, J. I., S. J. Kim, H. J. Cho, K. Jhung, S. Y. Lee, E. Lee and S. K. An (2012). "Psychometric analysis of the Korean version of the Disgust Scale-Revised." Comprehensive Psychiatry **53**(5): 648-655.

Kaplan, H., K. Hill, J. Lancaster and A. M. Hurtado (2000). "A theory of human life history evolution: Diet, intelligence, and longevity." Evolutionary Anthropology **9**(4): 156-185.

Katayama, N., Y. Ishikawa, M. Takaoki, M. Yamashita, S. Nakayama, K. Kiguchi, R. Kok, H. Wada, J. Mitsuhashi and S. A. T. Force (2008). "Entomophagy: A key to space agriculture." Advances in Space Research **41**(5): 701-705.

Kato, Y. (1987). "Light Requirement for Green Pigmentation of the Wild Silkworm Antheraea-Yamamai Cocoons - Local Irradiation and Parabiosis Experiments." Zoological Science **4**(6): 969-969.

Kazanas, N. and M. L. Fields (1981). "Nutritional Improvement of Sorghum by Fermentation." Journal of Food Science **46**(3): 819-821.

Kearney, M., J. M. Kearney and M. J. Gibney (1997). "Methods used to conduct the survey on consumer attitudes to food, nutrition and health on nationally representative samples of adults from each member state of the European Union." European Journal of Clinical Nutrition **51**: S3-S7.

Kelemu, S. (2015). "Insects: an overlooked food source Foreword." International Journal of Tropical Insect Science **35**(1): 1-2.

Kellert, S. R. (1993). "Values and Perceptions of Invertebrates." Conservation Biology **7**(4): 845-855.

Kim, E. H., C. Ebesutani, J. Young and B. O. Olatunji (2013). "Factor Structure of the Disgust Scale-Revised in an Adolescent Sample." Assessment **20**(5): 620-631.

Kjellstrom, T., B. Lemke and M. Otto (2013). "Mapping Occupational Heat Exposure and Effects in South-East Asia: Ongoing Time Trends 1980-2011 and Future Estimates to 2050." Industrial Health **51**(1): 56-67.

Klink, A. (2014). "Noncommunicable Diseases in the Developing World: Addressing Gaps in Global Policy and Research." Library Journal **139**(1): 129-129.

Klunder, H. C., J. Wolkers-Rooijackers, J. M. Korpela and M. J. R. Nout (2012). "Microbiological aspects of processing and storage of edible insects." Food Control **26**(2): 628-631.

Komprda, T., G. Zornikova, V. Rozikova, M. Borkovcova and A. Przywarova (2013). "The effect of dietary Salvia hispanica seed on the content of n-3 long-chain polyunsaturated fatty acids in tissues of selected animal species, including edible insects." Journal of Food Composition and Analysis **32**(1): 36-43.

Laureati, M., V. Bergamaschi and E. Pagliarini (2015). "Assessing childhood food neophobia: Validation of a scale in Italian primary school children." Food Quality and Preference **40**: 8-15.

Leibensperger, E. M., L. J. Mickley, D. J. Jacob, W. T. Chen, J. H. Seinfeld, A. Nenes, P. J. Adams, D. G. Streets, N. Kumar and D. Rind (2012). "Climatic effects of 1950-2050 changes in US anthropogenic aerosols - Part 1: Aerosol trends and radiative forcing." Atmospheric Chemistry and Physics **12**(7): 3333-3348.

Lensvelt, E. J. and L. P. Steenbekkers (2014). "Exploring Consumer Acceptance of Entomophagy: A Survey and Experiment in Australia and the Netherlands." Ecol Food Nutr **53**(5): 543-561.

Lensvelt, E. J. S. and L. P. A. Steenbekkers (2014). "Exploring Consumer Acceptance of Entomophagy: A Survey and Experiment in Australia and the Netherlands." Ecology of Food and Nutrition **53**(5): 543-561.

Li, F., Y. S. Kwon, M. J. Bae, N. Chung, T. S. Kwon and Y. S. Park (2014). "Potential impacts of global warming on the diversity and distribution of stream insects in South Korea." Conserv Biol **28**(2): 498-508.

Lindeman, M. and M. Vaananen (2000). "Measurement of ethical food choice motives." Appetite **34**(1): 55-59.

Liu, Q. L., J. K. Tomberlin, J. A. Brady, M. R. Sanford and Z. N. Yu (2008). "Black Soldier Fly (Diptera: Stratiomyidae) Larvae Reduce Escherichia coli in Dairy Manure." Environmental Entomology **37**(6): 1525-1530.

Loo, S. and U. Sellbach (2013). "Eating (with) Insects: Insect Gastronomies and Upside-Down Ethics." Parallax **19**(1): 12-28.

Looy, H., F. V. Dunkel and J. R. Wood (2014). "How then shall we eat? Insect-eating attitudes and sustainable foodways." Agriculture and Human Values **31**(1): 131-141.

Machovina, B. and K. J. Feeley (2014). "Livestock: limit red meat consumption." Nature **508**(7495): 186-186.

Makkar, H. P. S., G. Tran, V. Henze and P. Ankers (2014). "State-of-the-art on use of insects as animal feed." Animal Feed Science and Technology **197**: 1-33.

Manzano-Agugliaro, F., M. J. Sanchez-Muros, F. G. Barroso, A. Martinez-Sanchez, S. Rojo and C. Perez-Banon (2012). "Insects for biodiesel production." Renewable & Sustainable Energy Reviews **16**(6): 3744-3753.

Mariod, A. A. and H. Fadul (2015). "Extraction and characterization of gelatin from two edible Sudanese insects and its applications in ice cream making." Food Sci Technol Int **21**(5): 380-391.

Markovina, J., B. J. Stewart-Knox, A. Rankin, M. Gibney, M. D. V. de Almeida, A. Fischer, S. A. Kuznesof, R. Poinhos, L. Panzone and L. J. Frewer (2015). "Food4Me study: Validity and reliability of Food Choice Questionnaire in 9 European countries." Food Quality and Preference **45**: 26-32.

Martins, Y. and P. Pliner (2005). "Human food choices: An examination of the factors underlying acceptance/rejection of novel and familiar animal and nonanimal foods." Appetite **45**(3): 214-224.

Mauleon, H., N. Barre and S. Panoma (1993). "Pathogenicity of 17 isolates of entomophagous nematodes (Steinernematidae and Heterorhabditidae) for the ticks Amblyomma variegatum (Fabricius), Boophilus microplus (Canestrini) and Boophilus annulatus (Say)." Exp Appl Acarol **17**(11): 831-838.

May, M. L. (2005). "Hot bugs: Body temperature of insects in sunshine." Journal of Experimental Biology **208**(14): 2623-2624.

Mazzonetto, A. C. and G. M. R. Fiates (2014). "Perceptions and choices of Brazilian children as consumers of food products." Appetite **78**: 179-184.

Mbata, K. J., E. N. Chidumayo and C. M. Lwatula (2002). "Traditional regulation of edible caterpillar exploitation in the Kopa area of Mpika district in northern Zambia." Journal of Insect Conservation **6**(2): 115-130.

McCusker, S., P. R. Buff, Z. Yu and A. J. Fascetti (2014). "Amino acid content of selected plant, algae and insect species: a search for alternative protein sources for use in pet foods." J Nutr Sci **3**: e39.

McFarlane, T. and P. Pliner (1997). "Increasing willingness to taste novel foods: Effects of nutrition and taste information." Appetite **28**(3): 227-238.

McGrew, W. C. (2014). "The 'other faunivory' revisited: Insectivory in human and non-human primates and the evolution of human diet." J Hum Evol **71**: 4-11.

McInerney, J. (2007). "The sushi economy - Globalization and the making of a modern delicacy." New York Times Book Review: 12-13.

McInerney, J. (2007). "The 'Zen of fish' - The story of sushi, from samurai to supermarket." New York Times Book Review: 12-13.

McMahon, K. W., S. R. Thorrold, T. S. Elsdon and M. D. McCarthy (2015). "Trophic discrimination of nitrogen stable isotopes in amino acids varies with diet quality in a marine fish." Limnology and Oceanography **60**(3): 1076-1087.

Megido, R. C., L. Sablon, M. Geuens, Y. Brostaux, T. Alabi, C. Blecker, D. Drugmand, E. Haubruge and F. Francis (2014). "Edible Insects Acceptance by Belgian Consumers: Promising Attitude for Entomophagy Development." Journal of Sensory Studies **29**(1): 14-20.

Melo, V., A. Chavez, M. Chavez, R. Casillas and C. Maass (2004). "Atizies taxcoensis A and Euchistus sufultus S, jumil bugs: nutraceutic foodstuff for iodine deficiency." Metal Ions in Biology and Medicine, Vol 8 **8**: 324-329.

Melo-Ruiz, V., K. Sanchez-Herrera, M. Garcia-Nunez, R. Diaz-Garcia and L. Garcia (2013). "Edible insects source of nutrients to improve food security worldwide." Proceedings of the Nutrition Society **72**(Oce5): E317-E317.

Merzendorfer, H. (2011). "The cellular basis of chitin synthesis in fungi and insects: Common principles and differences." European Journal of Cell Biology **90**(9): 759-769.

Meyer-Rochow, V. B. (1973). "Edible insects in three different ethnic groups of Papua and New Guinea." Am J Clin Nutr **26**(6): 673-677.

Meyer-Rochow, V. B. and J. Chakravorty (2013). "Notes on entomophagy and entomotherapy generally and information on the situation in India in particular." Applied Entomology and Zoology **48**(2): 105-112.

Meyerroc.Vb (1973). "Edible Insects in 3 Different Ethnic Groups of Papua and New-Guinea." American Journal of Clinical Nutrition **26**(6): 673-677.

Meyerrochow, V. B. (1975). "Can Insects Help to Ease Problem of World Food Shortage." Search **6**(7): 261-262.

MeyerRochow, V. B. and S. Changkija (1997). "Uses of insects as human food in Papua New Guinea, Australia, and North-east India: Cross-cultural considerations and cautious conclusions." Ecology of Food and Nutrition **36**(2-4): 159-&.

Milosevic, J., I. Zezelj, M. Gorton and D. Barjolle (2012). "Understanding the motives for food choice in Western Balkan Countries." Appetite **58**(1): 205-214.

Mitsuhashi, R., H. Mizuno, S. Saeki, S. I. Uchiyama, M. Yoshida, Y. Takamatsu, H. Fugo and E. I. S. Meeting (2013). "Radioactive Caesium Contamination in Inago and Sustainability of Inago Cuisine in Fukushima." Food Hygiene and Safety Science **54**(6): 410-414.

Mlcek, J., O. Rop, M. Borkovcova and M. Bednarova (2014). "A Comprehensive Look at the Possibilities of Edible Insects as Food in Europe - a Review." Polish Journal of Food and Nutrition Sciences **64**(3): 147-157.

Modesto, S. P., D. M. Scott and R. R. Reisz (2009). "Arthropod remains in the oral cavities of fossil reptiles support inference of early insectivory." Biol Lett **5**(6): 838-840.

Moon, H. B., H. S. Kim, M. Choi, J. Yu and H. G. Choi (2009). "Human health risk of polychlorinated biphenyls and organochlorine pesticides resulting from seafood consumption in South Korea, 2005-2007." Food and Chemical Toxicology **47**(8): 1819-1825.

Motte-Florac, E. and J. Ramos-Elorduy (2002). "Is the traditional knowledge of insects important?" Ethnobiology and Biocultural Diversity, Proceedings: 207-224.

Musiani, M. and E. Visalberghi (2000). "Wolves' avoidance of flag barriers and management implications." Animal Welfare **9**(1): 108-108.

Nachay, K. (2013). "Insects as a Sustainable, Nutritional Food Source." Food Technology **67**(7): 18-18.

Nadeau, L., I. Nadeau, F. Franklin and F. Dunkel (2015). "The Potential for Entomophagy to Address Undernutrition." Ecology of Food and Nutrition **54**(3): 200-208.

Nadeau, L., I. Nadeau, F. Franklin and F. Dunkel (2015). "The potential for entomophagy to address undernutrition." Ecol Food Nutr **54**(3): 200-208.

Naranjo-Lazaro, J. M., M. A. Mellin-Rosas, V. D. Gonzalez-Padilla, J. A. Sanchez-Gonzalez, G. Moreno-Carrillo and H. C. Arredondo-Bernal (2014). "Susceptibility of Drosophila suzukii Matsumura (Diptera: Drosophilidae) to Entomophatogenic Fungi." Southwestern Entomologist **39**(1): 201-203.

Navon, A., S. Keren, L. Salame and I. Glazer (1998). "An edible-to-insects calcium alginate gel as a carrier for entomopathogenic nematodes." Biocontrol Science and Technology **8**(3): 429-437.

Neuerburg, L. (2014). "Planet of the Bugs: Evolution and the Rise of Insects." Library Journal **139**(12): 110-110.

O'Malley, R. C. and M. L. Power (2014). "The energetic and nutritional yields from insectivory for Kasekela chimpanzees." J Hum Evol **71**: 46-58.

O'neill, V., S. Hess and D. Campbell (2014). "A question of taste: Recognising the role of latent preferences and attitudes in analysing food choices." Food Quality and Preference **32**: 299-310.

Obopile, M. and T. G. Seeletso (2013). "Eat or not eat: an analysis of the status of entomophagy in Botswana." Food Security **5**(6): 817-824.

Oftedal, O. T. (1991). "The nutritional consequences of foraging in primates: the relationship of nutrient intakes to nutrient requirements." Philos Trans R Soc Lond B Biol Sci **334**(1270): 161-169, discussion 169-170.

Ohman, A. (1986). "Face the Beast and Fear the Face - Animal and Social Fears as Prototypes for Evolutionary Analyses of Emotion." Psychophysiology **23**(2): 123-145.

Oonincx, D. G. A. B. and I. J. M. de Boer (2012). "Environmental Impact of the Production of Mealworms as a Protein Source for Humans - A Life Cycle Assessment." Plos One **7**(12).

Oonincx, D. G. A. B., J. van Itterbeeck, M. J. W. Heetkamp, H. van den Brand, J. J. A. van Loon and A. van Huis (2010). "An Exploration on Greenhouse Gas and Ammonia Production by Insect Species Suitable for Animal or Human Consumption." Plos One **5**(12).

Paoletti, M. G. and S. G. F. Bukkens (1997). "Minilivestock - Preface." Ecology of Food and Nutrition **36**(2-4): R3-R4.

Park, S. I., J. W. Kim and S. M. Yoe (2015). "Purification and characterization of a novel antibacterial peptide from black soldier fly (Hermetia illucens) larvae." Dev Comp Immunol **52**(1): 98-106.

Pascucci, S. and T. de-Magistris (2013). "Information Bias Condemning Radical Food Innovators? The Case of Insect-Based Products in the Netherlands." International Food and Agribusiness Management Review **16**(3): 1-16.

Pauperio, A., M. Severo, C. Lopes, P. Moreira, L. Cooke and A. Oliveira (2014). "Could the Food Neophobia Scale be adapted to pregnant women? A confirmatory factor analysis in a Portuguese sample." Appetite **75**: 110-116.

Payne, C. L. R. and K. Nonaka (2014). "Cooperative hunting for wasps, opportunistic gathering of grasshoppers: The behavioural ecology of insect consumption in rural Japan." American Journal of Physical Anthropology **153**: 205-205.

Pelchat, M. L. and P. Pliner (1995). "Try It - Youll Like It - Effects of Information on Willingness to Try Novel Foods." Appetite **24**(2): 153-165.

Pellett, P. L. (1997). "Minilivestock - Foreword." Ecology of Food and Nutrition **36**(2-4): R1-R2.

Pieniak, Z., F. Perez-Cueto and W. Verbeke (2013). "Nutritional status, self-identification as a traditional food consumer and motives for food choice in six European countries." British Food Journal **115**(9): 1297-1312.

Pimentel, D., M. McNair, L. Duck, M. Pimentel and J. Kamil (1997). "The value of forests to world food security." Human Ecology **25**(1): 91-120.

Pliner, P. and K. Hobden (1992). "Development of a Scale to Measure the Trait of Food Neophobia in Humans." Appetite **19**(2): 105-120.

Pollard, T. M., A. Steptoe and J. Wardle (1998). "Motives underlying healthy eating: Using the food choice questionnaire to explain variation in dietary intake." Journal of Biosocial Science **30**(2): 165-179.

Popp, A., H. Lotze-Campen, M. Leimbach, B. Knopf, T. Beringer, N. Bauer and B. Bodirsky (2011). "On sustainability of bioenergy production: Integrating co-emissions from agricultural intensification." Biomass & Bioenergy **35**(12): 4770-4780.

Premalatha, M., T. Abbasi, T. Abbasi and S. A. Abbasi (2011). "Energy-efficient food production to reduce global warming and ecodegradation: The use of edible insects." Renewable & Sustainable Energy Reviews **15**(9): 4357-4360.

Prescott, J., O. Young, L. O'Neill, N. J. N. Yau and R. Stevens (2002). "Motives for food choice: a comparison of consumers from Japan, Taiwan, Malaysia and New Zealand." Food Quality and Preference **13**(7-8): 489-495.

Previato, H. D. R. D. and J. H. Behrens (2015). "Translation and Validation of the Food Neophobia Scale (FNS) to the Brazilian Portuguese." Nutricion Hospitalaria **32**(2): 925-930.

Pula, K., C. D. Parks and C. F. Ross (2014). "Regulatory focus and food choice motives. Prevention orientation associated with mood, convenience, and familiarity." Appetite **78**: 15-22.

Raksakantong, P., N. Meeso, J. Kubola and S. Siriamornpun (2010). "Fatty acids and proximate composition of eight Thai edible terricolous insects." Food Research International **43**(1): 350-355.

Ramos-Elorduy, J. (2005). "Insects: a hopeful food source." In M.G. Paoletti, ed. Ecological implications of minilivestock: 263-291.

Ramos-Elorduy, J. (2006). "Threatened edible insects in Hidalgo, Mexico and some measures to preserve them." J Ethnobiol Ethnomed **2**: 51.

Ramos-Elorduy, J. (2008). "Energy supplied by edible insects from Mexico and their nutritional and ecological importance." Ecology of Food and Nutrition **47**(3): 280-297.

Rappoport, L. H., G. R. Peters, L. Huffcorzine and R. G. Downey (1992). "Reasons for Eating - an Exploratory Cognitive Analysis." Ecology of Food and Nutrition **28**(3): 171-189.

Raubenheimer, D. and J. M. Rothman (2013). "Nutritional Ecology of Entomophagy in Humans and Other Primates." Annual Review of Entomology, Vol 58 **58**: 141-160.

Raubenheimer, D., J. M. Rothman, H. Pontzer and S. J. Simpson (2014). "Macronutrient contributions of insects to the diets of hunter-gatherers: A geometric analysis." Journal of Human Evolution **71**: 70-76.

Ray, D. K., N. D. Mueller, P. C. West and J. A. Foley (2013). "Yield Trends Are Insufficient to Double Global Crop Production by 2050." Plos One **8**(6).

Reinhard, K. J., K. L. Johnson, S. LeRoy-Toren, K. Wieseman, I. Teixeira-Santos and M. Vieira (2012). "Understanding the Pathoecological Relationship between Ancient

Diet and Modern Diabetes through Coprolite Analysis A Case Example from Antelope Cave, Mojave County, Arizona." Current Anthropology **53**(4): 506-512.

Ritchey, P. N., R. A. Frank, U. K. Hursti and H. Tuorila (2003). "Validation and cross-national comparison of the food neophobia scale (FNS) using confirmatory factor analysis." Appetite **40**(2): 163-173.

Roberto, C. A. and N. Khandpur (2014). "Improving the design of nutrition labels to promote healthier food choices and reasonable portion sizes." International Journal of Obesity **38**: S25-S33.

Rodriguez-Miranda, J., B. Ramirez-Wong, M. A. Vivar-Veral, A. Solis-Soto, C. A. Gomez-Aldapa, J. Castro-Rosas, H. Medrano-Roldan and E. Degado-Licon (2014). "Effect of Bean Flour Concentration (Phaseolus Vulgaris L.), Moisture Content and Extrusion Temperature on the Functional Properties of Aquafeeds." Revista Mexicana De Ingenieria Quimica **13**(3): 649-663.

Rodriguez-Oliveros, M. G., C. A. Bisogni and E. A. Frongillo (2014). "Knowledge about food classification systems and value attributes provides insight for understanding complementary food choices in Mexican working mothers." Appetite **83**: 144-152.

Rothman, J. M., D. Raubenheimer, M. A. H. Bryer, M. Takahashi and C. C. Gilbert (2014). "Nutritional contributions of insects to primate diets: Implications for primate evolution." Journal of Human Evolution **71**: 59-69.

Rozin, P. (1985). "Disgust." Bulletin of the British Psychological Society **38**(May): A75-A76.

Rozin, P. (2014). Getting people to eat more insects. Insects to feed the world. Wageningen, Netherlands.

Rozin, P. and A. Fallon (1985). "Thats Disgusting." Psychology Today **19**(7): 60-63.

Rozin, P. and A. E. Fallon (1987). "A Perspective on Disgust." Psychological Review **94**(1): 23-41.

Rozin, P., C. Fischler, C. Shields and E. Masson (2006). "Attitudes towards large numbers of choices in the food domain: A cross-cultural study of five countries in Europe and the USA." Appetite **46**(3): 304-308.

Rozin, P. and J. Haidt (2013). "The domains of disgust and their origins: contrasting biological and cultural evolutionary accounts." Trends in Cognitive Sciences **17**(8): 367-368.

Rozin, P., J. Haidt, C. McCauley, L. Dunlop and M. Ashmore (1999). "Individual differences in disgust sensitivity: Comparisons and evaluations of paper-and-pencil versus behavioral measures." Journal of Research in Personality **33**(3): 330-351.

Rozin, P., L. Lowery and R. Ebert (1994). "Varieties of Disgust Faces and the Structure of Disgust." Journal of Personality and Social Psychology **66**(5): 870-881.

Rozin, P., C. Taylor, L. Ross, G. Bennett and A. Hejmadi (2005). "General and specific abilities to recognise negative emotions, especially disgust, as portrayed in the face and the body." Cognition & Emotion **19**(3): 397-412.

Rozin, P. and T. A. Vollmecke (1986). "Food Likes and Dislikes." Annual Review of Nutrition **6**: 433-456.

Rumpold, B. A., H. Katz, P. Katz and O. Schluter (2014). "Insects in the Human Diet - An alternative resource-efficient Protein Source as a Contribution to Food Security." Deutsche Lebensmittel-Rundschau **110**(2): 87-90.

Rumpold, B. A. and O. K. Schluter (2013). "Nutritional composition and safety aspects of edible insects." Mol Nutr Food Res **57**(5): 802-823.

Rumpold, B. A. and O. K. Schluter (2013). "Potential and challenges of insects as an innovative source for food and feed production." Innovative Food Science & Emerging Technologies **17**: 1-11.

Ryan, M. (2014). "Edible Insects: Future Prospects for Food and Feed Security." Library Journal **139**(9): 32-32.

Schabereiter-Gurtner, C., C. Saiz-Jimenez, G. Pinar, W. Lubitz and S. Rolleke (2002). "Altamira cave Paleolithic paintings harbor partly unknown bacterial communities." FEMS Microbiol Lett **211**(1): 7-11.

Scholtz, M. M., H. C. Schonfeldt, F. W. C. Neser and G. M. Schutte (2014). "Research and development on climate change and greenhouse gases in support of climatesmart livestock production and a vibrant industry." South African Journal of Animal Science **44**(5): S1-S7.

Schonberg, T., A. Bakkour, A. M. Hover, J. A. Mumford and R. A. Poldrack (2014). "Influencing Food Choices by Training: Evidence for Modulation of Frontoparietal Control Signals." Journal of Cognitive Neuroscience **26**(2): 247-268.

Schosler, H., J. de Boer and J. J. Boersema (2012). "Can we cut out the meat of the dish? Constructing consumer-oriented pathways towards meat substitution." Appetite **58**(1): 39-47.

Schosler, H., J. de Boer and J. J. Boersema (2014). "Fostering more sustainable food choices: Can Self-Determination Theory help?" Food Quality and Preference **35**: 59-69.

Shackleton, S. E., C. M. Dzerefos, C. M. Shackleton and F. R. Mathabela (1998). "Use and trading of wild edible herbs in the Central Lowveld Savanna Region, South Africa." Economic Botany **52**(3): 251-259.

Shackleton, S. E., C. M. Shackleton, T. R. Netshiluvhi, B. S. Geach, A. Ballance and D. H. K. Fairbanks (2002). "Use patterns and value of savanna resources in three rural villages in South Africa." Economic Botany **56**(2): 130-146.

Shantibala, T., R. Lokeshwari, G. Thingnam and B. G. Somkuwar (2012). "MEIMAN: Database exploring Medicinal and Edible insects of Manipur." Bioinformation **8**(10): 489-491.

Shantibala, T., R. K. Lokeshwari and H. Debaraj (2014). "Nutritional and antinutritional composition of the five species of aquatic edible insects consumed in Manipur, India." J Insect Sci **14**: 14.

Shepherd, C. J. and A. J. Jackson (2013). "Global fishmeal and fish-oil supply: inputs, outputs and markets." Journal of Fish Biology **83**(4): 1046-1066.

Siegrist, M., C. Hartmann and C. Keller (2013). "Antecedents of food neophobia and its association with eating behavior and food choices." Food Quality and Preference **30**(2): 293-298.

Skinner, M. F. (1994). "The Cambridge Encyclopedia of Human-Evolution - Jones,S, Martin,R, Pilbean,D." Current Anthropology **35**(3): 326-327.

Smith, R. (2014). Do European citizens accept the use of insects for animal feed & human food? Insects to feed the world. Wageningen.

Sneyd, L. Q. (2013). "Wild Food, Prices, Diets and Development: Sustainability and Food Security in Urban Cameroon." Sustainability **5**(11): 4728-4759.

Soares, T. M., D. A. Coutinho, L. D. Lacerda, M. O. Moraes and M. F. Rebelo (2011). "Mercury accumulation and metallothionein expression from aquafeeds by Litopenaeus vannamei Boone, 1931 under intensive aquaculture conditions." Brazilian Journal of Biology **71**(1): 131-137.

Srivastava, S. K., N. Babu and H. Pandey (2009). "Traditional insect bioprospecting - As human food and medicine." Indian Journal of Traditional Knowledge **8**(4): 485-494.

Stehfest, E. (2014). "DIET Food choices for health and planet." Nature **515**(7528): 501-502.

Steptoe, A., T. M. Pollard and J. Wardle (1995). "Development of a Measure of the Motives Underlying the Selection of Food - the Food Choice Questionnaire." Appetite **25**(3): 267-284.

Steptoe, A., T. M. Pollard and J. Wardle (1995). "Development of a measure of the motives underlying the selection of food: the food choice questionnaire." Appetite **25**(3): 267-284.

Stork, N. E., P. S. Grimbacher, R. Storey, R. G. Oberprieler, C. Reid and S. A. Slipinski (2008). "What determines whether a species of insect is described? Evidence from a study of tropical forest beetles." Insect Conservation and Diversity **1**(2): 114-119.

Sundberg, F., M. Augustsson, G. Forsander, U. Cederholm and M. Axelsen (2014). "Children under the age of seven with diabetes are increasing their cardiovascular risk by their food choices." Acta Paediatrica **103**(4): 404-410.

Sutton, Q. (1995). "Arqueological aspects of insect use." Journal of Arqueological Method and Theory **2**(3): 253.

Tacon, A. G. J. and M. Metian (2008). "Global overview on the use of fish meal and fish oil in industrially compounded aquafeeds: Trends and future prospects." Aquaculture **285**(1-4): 146-158.

Thompson, S. N. (1999). "Nutrition and culture of entomophagous insects." Annu Rev Entomol **44**: 561-592.

Thorndike, A. N., J. Riis, L. M. Sonnenberg and D. E. Levy (2014). "Traffic-Light Labels and Choice Architecture Promoting Healthy Food Choices." American Journal of Preventive Medicine **46**(2): 143-149.

Tong, L., X. Yu and H. Liu (2011). "Insect food for astronauts: gas exchange in silkworms fed on mulberry and lettuce and the nutritional value of these insects for human consumption during deep space flights." Bulletin of Entomological Research **101**(5): 613-622.

Tuorila, H. and E. Monteleone (2009). "Sensory food science in the changing society: Opportunities, needs, and challenges." Trends in Food Science & Technology **20**(2): 54-62.

Turner, B. L. and A. L. Thompson (2013). "Beyond the Paleolithic prescription: incorporating diversity and flexibility in the study of human diet evolution." Nutr Rev **71**(8): 501-510.

Twine, W., D. Moshe, T. Netshiluvhi and V. Siphugu (2003). "Consumption and direct-use values of savanna bio-resources used by rural households in Mametja, a semi-arid area of Limpopo province, South Africa." South African Journal of Science **99**(9-10): 467-473.

Usamentiaga, P., F. Rodriguez, D. Martin-Gil, N. Saiz, E. Morchon, S. Alonso, J. Jerez and B. Bartolome (2005). "Protein contact dermatitis by fishing bait (Lumbrinereis latreilli)." Contact Dermatitis **53**(4): 236-237.

van der Spiegel, M., M. Y. Noordam and H. J. van der Fels-Klerx (2013). "Safety of Novel Protein Sources (Insects, Microalgae, Seaweed, Duckweed, and Rapeseed) and Legislative Aspects for Their Application in Food and Feed Production." Comprehensive Reviews in Food Science and Food Safety **12**(6): 662-678.

Van Hoof, K. J. M., L. Y. Hemeryck and L. Vanhaecke (2015). "Consumption of red and processed meat and human colorectal cancer Is there a link?" Vlaams Diergeneeskundig Tijdschrift **84**(1): 3-9.

van Huis, A. (2013). "Potential of insects as food and feed in assuring food security." Annu Rev Entomol **58**: 563-583.

van Huis, A. (2013). Potential of Insects as Food and Feed in Assuring Food Security. Annual Review of Entomology, Vol 58. M. R. Berenbaum. **58:** 563-583.

van Huis, A. (2013). "Potential of Insects as Food and Feed in Assuring Food Security." Annual Review of Entomology, Vol 58 **58**: 563-583.

Van Itterbeeck, J. and A. van Huis (2012). "Environmental manipulation for edible insect procurement: a historical perspective." J Ethnobiol Ethnomed **8**: 3.

van Overveld, M., P. J. de Jong and M. L. Peters (2010). "The Disgust Propensity and Sensitivity Scale - Revised: Its predictive value for avoidance behavior." Personality and Individual Differences **49**(7): 706-711.

Van Rooyen, C. J. (2014). "Towards 2050: Trends and Scenarios for African Agribusiness." International Food and Agribusiness Management Review **17**(B): 19-39.

Vanhonacker, F., E. J. Van Loo, X. Gellynck and W. Verbeke (2013). "Flemish consumer attitudes towards more sustainable food choices." Appetite **62**: 7-16.

Verbeke, W. (2015). "Profiling consumers who are ready to adopt insects as a meat substitute in a Western society." Food Quality and Preference **39**: 147-155.

Verbeke, W., T. Spranghers, P. De Clercq, S. De Smet, B. Sas and M. Eeckhout (2015). "Insects in animal feed: Acceptance and its determinants among farmers, agriculture sector stakeholders and citizens." Animal Feed Science and Technology **204**: 72-87.

Verkerk, M. C., J. Tramper, J. C. M. van Trijp and D. E. Martens (2007). "Insect cells for human food." Biotechnology Advances **25**(2): 198-202.

Virgili, A., L. Ligrone, S. Bacilieri and M. Corazza (2001). "Protein contact dermatitis in a fisherman using maggots of a flesh fly as bait." Contact Dermatitis **44**(4): 262-263.

Visalberghi, E. and E. Addessi (2000). "Seeing group members eating a familiar food enhances the acceptance of novel foods in capuchin monkeys." Animal Behaviour **60**: 69-76.

Vogel, G. (2010). "For More Protein, Filet of Cricket." Science **327**(5967): 811-811.

von Ihering, R. (1930). "Entomophagy of 'tico-tico' (Brachyspiza capensis)." Comptes Rendus Des Seances De La Societe De Biologie Et De Ses Filiales **103**: 1319-1319.

von Koerber, K. and C. Leitzmann (2011). "World Food global food supply for a growing world population." Ernahrungs Umschau **58**(12): 668-673.

Wansink, B. and J. Sobal (2007). "Mindless eating - The 200 daily food decisions we overlook." Environment and Behavior **39**(1): 106-123.

Wansink, B., S. T. Sonka and S. B. Park (2004). "Segmentation approaches that differentiate consumption frequency from sensory preference." Journal of Sensory Studies **19**(4): 327-340.

Webster, T. H., W. C. McGrew, L. F. Marchant, C. L. Payne and K. D. Hunt (2014). "Selective insectivory at Toro-Semliki, Uganda: comparative analyses suggest no 'savanna' chimpanzee pattern." J Hum Evol **71**: 20-27.

Wehi, P. M., D. Raubenheimer and M. Morgan-Richards (2013). "Tolerance for Nutrient Imbalance in an Intermittently Feeding Herbivorous Cricket, the Wellington Tree Weta." Plos One **8**(12).

Wilkinson, D. S., S. Fregert, B. Magnusson, H. J. Bandmann, C. D. Calnan, E. Cronin, N. Hjorth, H. J. Maibach, K. E. Malalten, C. L. Meneghini and V. Pirila (1970). "Terminology of contact dermatitis." Acta Derm Venereol **50**(4): 287-292.

Wille, J. E. (1951). "Biological Control of Certain Cotton Insects and the Application of New Organic Insecticides in Peru'." Journal of Economic Entomology **44**(1): 13-18.

Wiorkows, J. (1970). "Estimation of Proportion of Variance Explained by Regression, When Number of Parameters in Model May Depend on Sample Size." Technometrics **12**(4): 915-&.

Yang, L. F., S. Siriamornpun and D. Li (2006). "Polyunsaturated fatty acid content of edible insects in Thailand." Journal of Food Lipids **13**(3): 277-285.

Yates-Doerr, E. (2015). "The world in a box? Food security, edible insects, and "One World, One Health" collaboration." Soc Sci Med **129**: 106-112.

YhoungAree, J., P. Puwastien and G. A. Attig (1997). "Edible insects in Thailand: An unconventional protein source?" Ecology of Food and Nutrition **36**(2-4): 133-149.

Yoshida, M., D. Suzuki, K. Matsumoto, M. Shirota, K. Inoue, M. Takahashi, T. Morita and A. Ono (2013). "Simulation of acute reference dose (ARfD) settings for pesticides in Japan." J Toxicol Sci **38**(2): 205-214.

Zhao, W., L. X. Lu and Y. L. Tang (2010). "Research and Application Progress of Insect Antimicrobial Peptides on Food Industry." International Journal of Food Engineering **6**(6).

Appendix

Survey nº: ____________

U.PORTO
FACULDADE DE CIÊNCIAS
UNIVERSIDADE DO PORTO

Alternative Food Sources Questionnaire

This questionnaire is part of an international study for evaluation of alternative food sources.
All answers provided will be confidential. Thank you for your participation.

1. Please state the degree of importance for each of the following sentences. Choose from 1 = "Not important" to 7 = "Very important".

It is important that the food I eat on a typical day:

		1	2	3	4	5	6	7	
1. Is easy to prepare.	Not important	☐	☐	☐	☐	☐	☐	☐	Very important
2. Can be cooked very simply.	Not important	☐	☐	☐	☐	☐	☐	☐	Very important
3. Is packaged in an environmentally friendly way.	Not important	☐	☐	☐	☐	☐	☐	☐	Very important
4. Is very nutritious.	Not important	☐	☐	☐	☐	☐	☐	☐	Very important
5. Is easily available in shops and supermarkets.	Not important	☐	☐	☐	☐	☐	☐	☐	Very important
6. Takes no time to prepare.	Not important	☐	☐	☐	☐	☐	☐	☐	Very important
7. Can be bought in shops close to where I live or work.	Not important	☐	☐	☐	☐	☐	☐	☐	Very important
8. Has been produced in a way that animals have not experienced pain.	Not important	☐	☐	☐	☐	☐	☐	☐	Very important
9. Is good for my skin/teeth/hair/nails etc.	Not important	☐	☐	☐	☐	☐	☐	☐	Very important
10. Keeps me healthy.	Not important	☐	☐	☐	☐	☐	☐	☐	Very important
11. Is high in protein.	Not important	☐	☐	☐	☐	☐	☐	☐	Very important
12. Has been produced in a way that animals' rights have been respected.	Not important	☐	☐	☐	☐	☐	☐	☐	Very important
13. Is high in fiber and roughage.	Not important	☐	☐	☐	☐	☐	☐	☐	Very important
14. Contains a lot of vitamins and minerals.	Not important	☐	☐	☐	☐	☐	☐	☐	Very important
15. Has been produced in a way that has not shaken the balance of nature.	Not important	☐	☐	☐	☐	☐	☐	☐	Very important
16. Has been prepared in an environmentally friendly way.	Not important	☐	☐	☐	☐	☐	☐	☐	Very important

2. Please state your degree of agreement on each of the following sentences, by choosing from 1 = "Strongly disagree" to 7 = "Strongly agree":

		1	2	3	4	5	6	7	
1. I am constantly sampling new and different foods.	Strongly disagree	☐	☐	☐	☐	☐	☐	☐	Strongly agree
2. I am afraid to eat things I have never tried before.	Strongly disagree	☐	☐	☐	☐	☐	☐	☐	Strongly agree
3. If I don´t know what a food is, I won´t try it.	Strongly disagree	☐	☐	☐	☐	☐	☐	☐	Strongly agree
4. I like foods from different cultures.	Strongly disagree	☐	☐	☐	☐	☐	☐	☐	Strongly agree
5. I don´t trust new foods.	Strongly disagree	☐	☐	☐	☐	☐	☐	☐	Strongly agree
6. I like to try new ethnic restaurants.	Strongly disagree	☐	☐	☐	☐	☐	☐	☐	Strongly agree
7. I will eat almost everything.	Strongly disagree	☐	☐	☐	☐	☐	☐	☐	Strongly agree
8. Ethnic food looks too weird to eat.	Strongly disagree	☐	☐	☐	☐	☐	☐	☐	Strongly agree
9. At dinners and parties, I will try new foods.	Strongly disagree	☐	☐	☐	☐	☐	☐	☐	Strongly agree
10. I am very particular about the foods I eat.	Strongly disagree	☐	☐	☐	☐	☐	☐	☐	Strongly agree

3. Please indicate the extent of your awareness about eating insects by placing yourself in one of the six responses:

- ☐ **No, I have never heard of the eating of insects.**
- ☐ **I´ve heard that a few insects are edible.**
- ☐ **I´ve heard of the eating of insects in other cultures (i.e. African and Asian) .**
- ☐ **I´ve heard of the eating of insects at some restaurants.**
- ☐ **I have heard of the eating of insects but actually don´t know what it means.**
- ☐ **Yes, I have heard of the eating insects and I know what it means.**

4. Please state your degree of exposure to edible insects, by selecting the most appropriate option:

- ☐ **I've never tried edible insects.**
- ☐ **I've tried edible insects on a single occasion.**
- ☐ **I've tried edible insects on a few occasions.**
- ☐ **I eat edible insects seasonally.**
- ☐ **I eat edible insects regularly.**

5. Please answer each of the items bellow, expressing your degree of acceptance by choosing from 1 = "Totally reject" to 7 = "Totally accept".

If someone offers you a meal or a snack based on:

		1	2	3	4	5	6	7	
1. Beef from animals fed with feed incorporating insects or insect protein.	Totally reject	☐	☐	☐	☐	☐	☐	☐	Totally accept
2. Pork from animals fed with feed incorporating insects or insect protein.	Totally reject	☐	☐	☐	☐	☐	☐	☐	Totally accept
3. Edible insects.	Totally reject	☐	☐	☐	☐	☐	☐	☐	Totally accept
4. Sushi.	Totally reject	☐	☐	☐	☐	☐	☐	☐	Totally accept
5. Protein bar with flour made out of cricket.	Totally reject	☐	☐	☐	☐	☐	☐	☐	Totally accept
6. Poultry from animals fed with feed incorporating insects or insect protein.	Totally reject	☐	☐	☐	☐	☐	☐	☐	Totally accept
7. Fish from animals fed with feed incorporating insects or insect protein.	Totally reject	☐	☐	☐	☐	☐	☐	☐	Totally accept

6. Please express your degree of agreement on each of the following sentences by choosing from 1 = "Totally disagree" to 7 = "Totally agree".

		1	2	3	4	5	6	7	
1. I am offended by the idea of eating insects.	Totally disagree	☐	☐	☐	☐	☐	☐	☐	Totally agree
2. The idea of insects makes me ill.	Totally disagree	☐	☐	☐	☐	☐	☐	☐	Totally agree
3. Eating insects is disgusting.	Totally disagree	☐	☐	☐	☐	☐	☐	☐	Totally agree
4. The idea of insects makes me nauseous.	Totally disagree	☐	☐	☐	☐	☐	☐	☐	Totally agree
5. If an insect crawls on my favorite food I won´t eat it.	Totally disagree	☐	☐	☐	☐	☐	☐	☐	Totally agree

7. If you know some, please list up to four insects that are considered as edible:

____

____

____

____

8. Please fill out the items below with your information:

1. Gender: ☐ Male ☐ Female

2. Age: ______________

3. Marital status: ☐ Single ☐ Married/living as married ☐ Divorced / separated ☐ Widow (er)

4. Maximum level of educational achievement:

☐ **Less than high school**
☐ **High school**
☐ **Some college, no degree**
☐ **Graduate degree**
☐ **Post-graduate degree**
☐ **Technical/professional degree**

5. Occupation: ______________________

6. Economic Situation: **Very difficult** 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ **Well-off**

7. Nationality: ______________________

8. Place of residence: ______________________

Thank you for your participation!